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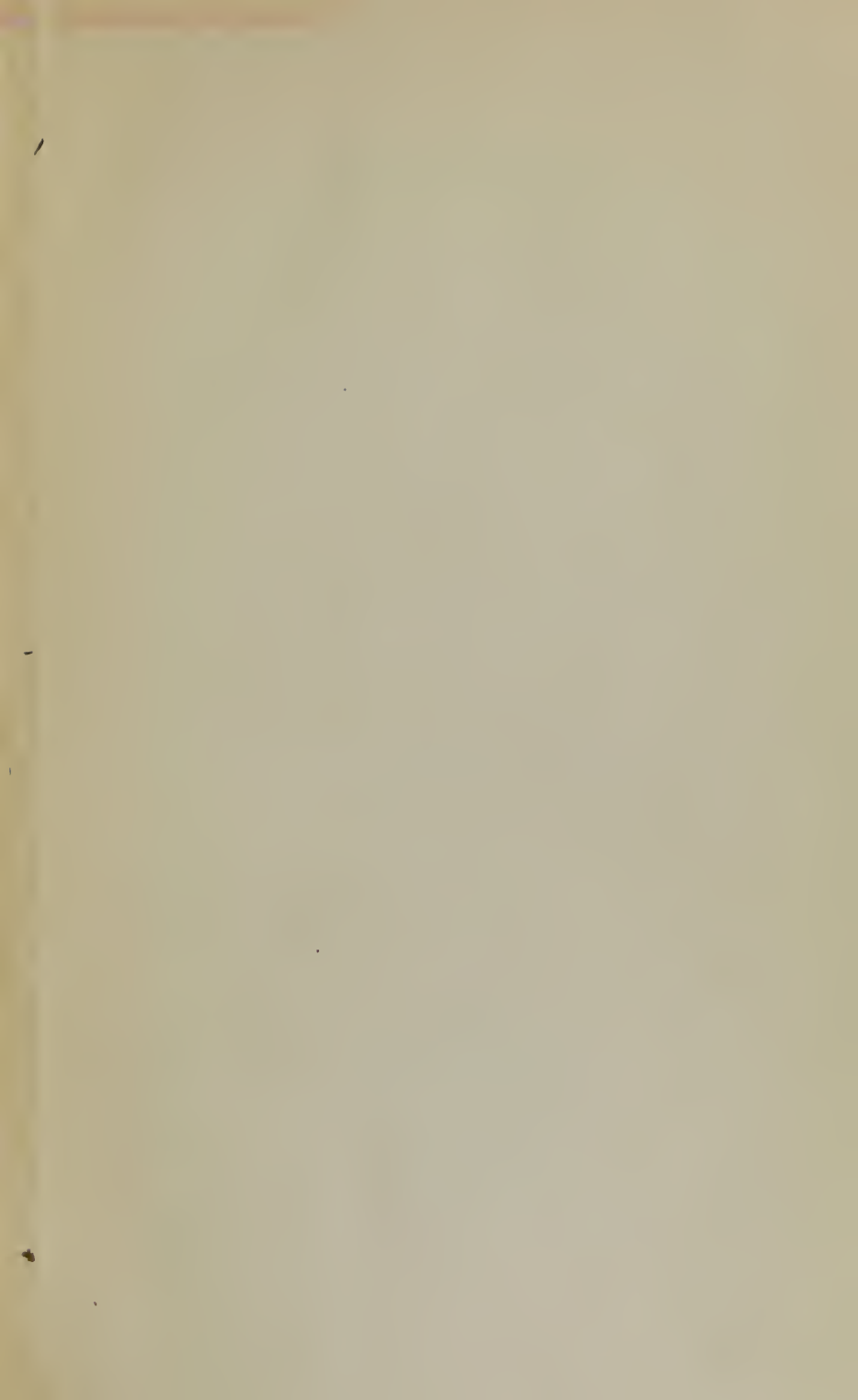
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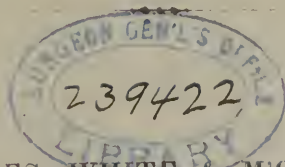


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TREATMENT  
OF  
DENTAL CARIES,  
COMPLICATED WITH  
DISORDERS OF THE PULP.

By R. ARTHUR, M. D., D. D. S.

PROFESSOR OF PRINCIPLES AND PRACTICE, IN THE PHILADELPHIA COLLEGE OF  
DENTAL SURGERY.



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It will be observed that some of the folios in this little volume are incorrect. The reader, however, can easily make the necessary allowance for this error, which was discovered too late to be corrected.

A T R E A T I S E

ON THE

T R E A T M E N T   O F   D E N T A L   C A R I E S ,

COMPLICATED WITH AFFECTIONS OF THE

D E N T A L   P U L P   A N D   P E R I D E N T A L   M E M B R A N E .

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C H A P T E R   I .

HAVING, for some years past, directed my attention, with interest, to the subjects which give a title to this paper, I now propose to present to the profession the results of my experience in relation to them, and also what I have gathered in my intercourse with other members of the profession.

The very satisfactory results which, in my own hands, have followed the practice of the operation of the entire extirpation of the dental pulp, and what I know to be the results of this practice in the hands of several of my friends, satisfy me that great good may be accomplished if the general attention of the profession can be seriously directed to this subject. The denunciations of this operation which, from time to time, have appeared in various places, have satisfied me that, when attempted, it could not have been performed in the thorough manner which I know is essential to success. As success has followed the practice which I have adopted, (and which is not by any means original with me, or peculiar to myself,) I have

felt it a duty to state, in full detail, what that practice is, so that it may be fairly and faithfully tried by all who think the objects to be gained worth the trial. If it is fairly and faithfully tried, I cannot see how the results can be different from what I and others have found them to be; and if these are obtained, I am sure any operator who adopts the practice, will be well repaid for his pains.

The general outlines of this practice have already been drawn, both in an editorial article which appeared in vol. vii of the "Journal," by Dr. Westcott, in an account of a visit to Dr. Maynard of this city; and in a series of excellent articles on the subject, by Dr. J. D. White, of Philadelphia, first published in the "Dental News Letter," of that city, and afterwards copied into the "Journal." But, in order that this operation should be attempted with probability of success, by those who have never before practiced it, I am satisfied that more should be told in detail, than what is stated in those articles. This is what I propose to do.

When I first thought of publishing my views upon this subject, it was my intention to confine myself to that branch of it to which I have alluded above. But, on considering the matter more attentively, I found so closely connected with this subject, several others, that I enlarged the original scope of my design, so as to embrace the treatment of the teeth after the pulp may have become in any manner involved, or in danger of being involved, in disease, or in the progress of necessary preservative operations. And as disorders of the peridental membrane so often accompany or are occasioned by treatment of the pulp, some examination of these disorders seemed to come naturally into this place.

It is generally an ungracious thing to make apologies in advance, for conscious imperfections of a work, and it may, perhaps, be said by some, that a writer ought to get rid of imperfections in what he ventures to publish. This, however, can never entirely be. And when a man is satisfied that he is able to say something which may either be useful in itself, or be likely to suggest what may be productive of good, he ought

to say it without delay. I am quite as well aware as any of my readers can ever become, of what will be found imperfect in the following treatise, and I can only hope that they will be stimulated to endeavor to supply all defects which they may discover in it.

As this treatise is intended, for the present at least, for members of the dental profession, who are supposed to be well acquainted with the anatomy of the teeth, I have determined to abandon my original intention of devoting a portion of it to a minute description of the dental pulp, and the cavities in which it is contained, in the various classes of the teeth. If, however, this effort proves to possess any value, and is favorably received, I may, at some future time, add these preliminary descriptions, and also the results of a number of investigations, upon which I am now engaged, in relation to the general subject, which cannot but prove useful, at least to the student of dental surgery, if not to the profession at large.

The preservation of the teeth, after that portion which is now generally designated the pulp, has been deprived of its bony covering, by disease or otherwise, has long been a desideratum, and has, on all hands, been acknowledged an object difficult of accomplishment. Many eminent practitioners of dental surgery, till within a very late period, have declared their belief, that any operation having this end in view, except in a very limited number of cases, would result to the injury of the patient upon whom it is practiced, and have accordingly denounced it in severe terms. A change, however, I am glad to perceive, is gradually taking place in this respect, and saves the necessity of meeting objections which have been urged against it on a variety of grounds—objections which it would be an easy matter to set aside.

Several methods have been employed to accomplish the object alluded to. These shall be briefly examined.

The French practitioners, who have, for many years, given much attention to the subject, advised, generally, the entire extirpation of the pulp, and relied, principally, upon the actual

cautery to effect this object. Many careful descriptions of the instruments for the purpose, and the manner in which they should be employed, are given by them. This operation, with them, however, was confined to the superior incisor and the inferior bicuspid teeth, which, they allege, are the only teeth in which the pulp, in its whole length, can be reached with the cauterizing instrument.

It was directed, after opening the internal cavity, so as to remove all obstruction, to heat the instrument, and thrust it quickly into the pulp, and to repeat this operation as long as any sensibility remained. Several days or weeks were then allowed to elapse, for the dissipation of any inflammation which might ensue, when the tooth was filled in the ordinary manner.

Fauchard, (vol. i, p. 175,) in a chapter on the treatment of painful teeth, describes an operation, which he calls trepanning the teeth. It is simply piercing the pulp with a fine needle, from which the temper has been taken out. After this has been done, for the purpose, he says, of giving egress to the humors which may be retained in the dental cavity, the tooth is to be left untouched for several weeks. The external cavity, he says, is to be filled with cotton, to prevent decay in the meantime, but care must be taken to avoid packing this so tightly as to prevent the escape of any matter which may be discharged from the dental cavity. Indeed, he sometimes found it necessary to remove, several times, the final metallic filling, to relieve pain which followed the operation from this cause. With the incisor and canine teeth, he alleges, he was generally successful in relieving the pain; and he advises that the operation should be confined to these. In cases where pain is not entirely relieved by this operation, he refers it to the peridental membrane, and notices, too, the fact, that pain sometimes continues even after the extraction of such teeth.

It is proposed, by Hunter, to extract teeth after the nerves have become exposed, boil them with a view to render them perfectly clean, and then return them to the sockets; after which, he says, as they are now dead, they cannot suffer any further from disease, but can only be acted upon chemically or me-

chanically. This practice he recommends in grinders only. No comment upon this practice is necessary at the present day. If the patient will not suffer the extraction of a tooth affected in this manner, (an operation to which the author alluded to gives preference,) he must have the nerve burned, and this, in order to be successful, must be done to the apex of the fang, which is not always possible. Any one of the concentrated acids is capable of destroying the soft parts of a tooth, if brought into contact with them. To the lower teeth these substances, he says, may be readily and conveniently applied, as they will pass down into the fang by their own gravity; but, for the same reason, they are not readily applicable to the upper teeth. For this purpose, caustic alkali is recommended, placed upon a dossil of lint, and pushed up into the dental canal.—(Hunter, Am. ed., part ii, pp. 7, 8.)

It has also been recommended to effect the destruction of the pulp, by the partial luxation of the painful tooth. The operation consisted in removing the tooth so far from the socket as to break up its connection with the jaw, and then immediately return it to its place.

The whole of the above class of agents have reference to the entire destruction of the dental pulp after it may have become exposed. The authorities for these methods of practice might be very much increased; but as they have deservedly gone almost, if not entirely, out of use, it is, of course, unnecessary.

Mr. Thomas Bell, (p. 151,) after noticing several of the methods of destroying the nerve mentioned above, with, it seems to me, unanswerable objections, deprecates the practice as painful and inefficient for the intended purpose. He does not place reliance upon any operation for the preservation of a tooth after the pulp has once become extensively exposed, but believes that all attempts of this kind will result to the injury of the patient. When, however, the pulp is very slightly exposed, he advises the use of agents which will remove its sensibility, or produce its absorption, “so as to render it capable of receiving the stopping without any pain or inconvenience.” For this purpose, he made use of alcohol, spirits of camphor, solu-

tion of nitrate of silver, &c., kept continually, for some time, in contact with the slightly exposed pulp. "It is," he says, "not easily determined, nor is it of much importance, in what way these applications produce the effect—whether by occasioning the actual absorption of that part of the membrane to which they are applied, or by gradually wearing out, as it were, its sensibility; it is sufficient, that experience proves them to be efficacious. I have generally preferred camphorated spirits or alcohol, as the nitrate of silver requires more caution in its management, and could not, perhaps, with safety, be left to the patient's own care. The liquid should be applied at least three or four times in the day, on a small bit of lint or cotton, the cavity being rendered perfectly dry, and its use should be continued until considerable pressure no longer occasions pain."—*Op. cit.* 154.

Koecker, (*Am. ed.*, p. 226,) in taking up this subject, after having denounced the practice of destroying the nerves of teeth in the manner commonly adopted at the time he wrote, asserts that the only rational manner in which a tooth can be treated after the exposure of the pulp, is the restoration to, and preservation of the health of this important part of the tooth. For this purpose, he adopted local treatment, to obtain the following results:

"1. To put a stop to the caries, and consequently to prevent the irritation upon the lining membrane of the tooth.

"2. To suppress the hemorrhage, and to cure the membrane if wounded.

"3. To protect the membrane, artificially, against the action of all foreign agents."

If the cavity of decay could be properly prepared without wounding the pulp, Dr. Koecker at once filled the cavity in the usual manner. But if the pulp was wounded, he arrested the hemorrhage by the actual cautery, which he applied by means of an iron wire, filed and bent, so as to adapt it perfectly to the form of the part of the pulp exposed; this he applied repeatedly to the part, taking care to avoid touching the adjacent bone. After having done this, he wiped out the

cavity—observing great caution not again to wound the pulp: allowed sufficient time to elapse for the original wound of the pulp to heal, when he proceeded to effect the third object proposed by him, the protection of this portion of the tooth against foreign agents. This he accomplished by laying over the exposed pulp a piece of thin leaf lead, and then filling up the cavity with gold, in the usual manner. After the completion of the operation, Dr. K. advises the patient to avoid any causes which will be likely to excite inflammation in the surrounding parts, and takes the proper means of subduing it on its first appearance. Dr. K. asserts that five out of six teeth may be preserved alive by this treatment, and mentions a case in which he succeeded perfectly with six, viz. one upper incisor, one cuspid, two bicuspid, one under bicuspid, and one molar.

I believe I have now presented the substance at least of what is on record, which has any bearing upon the treatment of the dental pulp, previously to the introduction of the arsenious acid as an agent for the purpose of effecting the entire destruction of this portion of the tooth.

It will be seen that little was done, so far at least as we may judge from what is on record, towards the performance of a thorough operation for the removal of the dental pulp, and the subsequent treatment of the tooth. The French writers recommended the removal of the pulp, either with an instrument, without any preparatory steps, or to destroy the sensibility, previously to doing this, by the actual cautery. Much was said about the manner of applying the cautery, but beyond this, the directions given for the subsequent treatment of the tooth, are very meagre indeed.

English writers generally condemned the operation, as will have been seen, and preferred making an effort to save the pulp alive.

The operation now practiced in this country, for the treatment of the teeth, after the pulp may have become uncovered, is entirely to remove this part of the tooth, as far up into the root as it can be reached by means of a delicate instrument, and after this is effectually done, to fill the place occupied by the pulp, up to the apex of the root, with gold.

It is difficult now to say, with certainty, who deserves the credit of having originated this operation. Dr. E. Baker has made, as far as I am aware, the first publication in relation to the subject,\* and after describing briefly the operation, states that the late Dr. Hudson, of Philadelphia, was in the habit, thirty years before that time, (1839,) of treating the front teeth in this manner, and with great success.

The operation for the entire extirpation of the pulp, and the complete filling of the fang, divides itself into two classes—that which confines it to the incisor and bicuspid teeth, and that which embraces all classes of the teeth. From evidence presented, it appears that the French practitioners, many years ago, were in the habit of removing the body of the pulp; but nothing has been left on record which will justify the belief that they attempted to practice the thorough operation of filling the fangs. Dr. Maynard, who appears to have taken great pains, during a late visit to Europe, to ascertain the exact condition of dental surgery there, states that he did not meet with a single individual, in England or on the continent, who had practiced the operation, and that he introduced it into St. Petersburg.

Dr. Baker, in the article above alluded to, states that the late Dr. Hudson, of Philadelphia, was in the habit of removing the pulp from the canal in the roots of the teeth, and filling carefully with gold; but he does not say this operation was performed upon the molar teeth. For a long time, whilst it has been admitted by some of the most decided opponents of the practice, that the operation might be allowable when confined to the incisor teeth, it was objected to, without qualification, when practiced upon the molar teeth. Now the operation, as applied to the molar teeth, I consider the most important feature of the treatment, for these teeth are really, in many cases, more valuable to the patient than the incisor teeth, which can be more easily replaced when lost.

I have carefully inquired into the origin of this operation upon the molar teeth. My attention was first called to it by Dr.

\* See Am. Jour. Dental Science, vol. i, p. 171:

J. D. White, of Philadelphia, who stated to me, it is now my impression, that he practiced it about ten years ago. Dr. E. Townsend, of Philadelphia, (see Journal for October, 1850,) states that he began to practice the operation in 1840, and has since performed it in many cases, but does not state whether he confined his operations to the incisor teeth, or practiced it without regard to the class. The first publication on the subject of performing this operation upon the molar teeth, as far as I am aware, was made by Dr. Dunning, in a paper on "Practical Dentistry," read before the sixth annual meeting of the American Society of Dental Surgeons, and published in the Journal of 1845. Dr. D., in this paper, objects to the use of arsenic for destroying the vitality of the pulp, and advises its removal with an instrument, without any preparatory treatment. After practicing it, more or less imperfectly, for several years, I took up my residence in Washington City. Dr. Maynard then described to me his most thorough manner of operating in these cases, and I adopted improvements he suggested, with great advantage. In conversation with him, he says he filled a molar tooth in this manner, as nearly as he can recollect, about thirteen years ago. He states, however, that the operation is not original with him; that it was first suggested to him by Dr. Cherry, of Alexandria, and that it is his impression that the Drs. Tucker, of Boston, practiced it long before he did. Of one thing, however, from a variety of evidence, convincing to me, I am satisfied that he was among the first, if not the first, who performed this delicate operation in the thorough manner in which it is now generally done to insure success. And I am satisfied that the present credit the operation has obtained in the profession, is, in a great measure, due to him.

Up to the year 1836, as far as I can learn, the operation of destroying and removing the dental pulp, was limited, in this country, to the incisor teeth, and was practiced by a few individuals only. At that time, the arsenious acid, as an agent for the destruction of the vitality of the pulp, previously to its removal, was introduced to the profession by Dr. S. Spooner, in a popular treatise, entitled "A Guide to Sound Teeth."

The use of this agent removed one of the most serious objections to the operation—its extreme painfulness. The surprising effects, and the uniform certainty with which they followed the application of this substance, induced, at once, its almost universal employment for the purpose of destroying the vitality of the pulp. It now became a common practice, not only to destroy the pulp of the front teeth, but of all the teeth. When a patient presented himself, to have a painful tooth removed, he was told that he could be certainly relieved of pain, without the loss of the tooth, which, probably of great value to him, could be saved and rendered useful. The tortured patient, glad to escape the terrible operation of extraction, readily consented. The arsenic was applied. If the pain did not immediately cease, in the course of a few hours at least he would be relieved. The next day, on coming to his dentist, he finds, to his great amazement, that the tooth, which the day before was so exceedingly sensitive that the mere contact of the air rendered him almost frantic, is now perfectly insensible. He can scarcely believe the evidence of his senses. The tooth is at once filled, and he leaves the office, loading his benefactor with thanks, and paying the fee for the operation, with expressions of gratitude. The operator was delighted that he could, with so much certainty and ease, accomplish such an important object.

It may be readily supposed that results such as these, brought it at once into general use. With the better class of practitioners, however, it was soon discarded, for, although the first effects were so satisfactory, it was soon found that bad consequences followed, which, with almost invariable certainty, made the extraction of the tooth, so treated, at last necessary. In the course of a few days, or sometimes weeks, inflammation of the peridental membrane set in; the whilom comfortable and useful tooth became at first tender to pressure, and apparently a little longer than its neighbors; in a few days more, came an attack of pain more serious than that which a few weeks before was so successfully relieved; the gum near the tooth enlarges, the pain becomes intense. The sufferer either goes at once and has the offending member extracted, or poultices his face

to hasten suppuration. After suffering excruciating pain for a time longer, relief came in the shape of an alveolar abscess; an ulcer is formed, and a continuous unpleasant discharge is established. In some cases, in the lower jaw, a fistulous opening is formed in the cheek, and when the cause of all this is finally removed, an unsightly scar is left to disfigure the face for life.

That these were the common results which followed the use of arsenic after its first introduction, is well known, and it is not at all surprising that its use should have been discouraged. In my own case, after using arsenic in this manner for a short time, I threw it aside as injurious.

After a time, however when the use of arsenic for the extirpation of the pulp was generally discontinued amongst the better class of practitioners, it was understood that several members of the profession, some of high repute, were using it habitually, applying it to any class of the teeth, and with alleged success. This brought forth a number of violent attacks upon the practice, and it was denounced as the worst kind of malpractice. No defence of the practice was made, rather from indifference to the attack—a feeling that it was uncourteous—and from a desire, on my own part at least, to let the matter take its own course, till time enough had elapsed to enable me, if no one else would do so, to present the practice in such a light that it would command the attention at least of the profession. But I now find myself forestalled, by a change which appears lately to have taken place in the views of some, who, a few years since, most loudly denounced its use, and who are now disposed, as they should have been long ago, to believe that there was some truth in the positive declarations of practitioners, whose character as men gave them at least a claim to credibility.

But if arsenic is made use of as the destructive agent in this operation, and it has been used improperly heretofore, what is the right manner of using it?

This has already been indicated, as I have said, in an article in the 7th volume of the "Journal," and in a series of excellent

articles on the "Treatment of the Dental Pulp," by Dr. White, of Philadelphia. What I propose to do now, is to present a description of the operation, in full detail; the symptoms in the course of treatment which have presented themselves in my hands; the causes of failure, and the cases in which success may be reasonably looked for.

The apparent want of a work specially devoted to this subject, at this time, has induced me to undertake the task. Although the treatment I shall advocate is not yet all that could be desired—still I am convinced, and hope I shall be able to convince others, who are incredulous now, that the subject is one of considerable importance to the community, and to the profession at large.

If a work devoted to this special subject could have been expected from others in the profession, I should most willingly have left it to abler hands. As I have undertaken the task, it shall be my effort to present the subject in a plain, straight-forward way. I shall endeavor to say that which may prove useful, and that only. I shall endeavor carefully to give credit to others, for what they may have done towards the improvement of this valuable practice; and if I should fail, in any instance, to do so, this will arise rather from a want of knowledge of facts, than from intentional neglect.

## CHAPTER II.

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### INFLAMMATION OF THE DENTINE.

THERE are few subjects connected with dental surgery, the study of which is of more practical importance than that exquisite sensibility of the dental bone, which so often presents itself even when caries of this part of the tooth is quite superficial. That this is a true inflammation of the part I am irresistibly led to conclude, both from a consideration of the structure of the teeth, and from the variety of phenomena which daily present themselves in practice, for which I am unable satisfactorily to account upon any other hypothesis.

I do not, at present, propose to enter very fully into the discussion of this question, but may on some future occasion do so. I will, however, state briefly the reasons which have brought me to the above conclusion.

The vitality of the bony portion of the teeth is not now questioned. It is, indeed, no longer a matter of theory, but has been repeatedly demonstrated, and the presence of red blood in certain conditions of the teeth has been clearly displayed in the dentine. It has been shown, by the late Mr. Alexander Nasmyth, that the dentine is endowed with a much higher de-

gree of vitality than is generally supposed. "The ivory," he says, "contains numerous fibres of animal matter composed of nuclei of cells arranged in a linear order, and these must be the agents of the transmission of sensation, although it must be admitted that no direct communication can be discovered between them and the nervous filaments; the fibres of the ivory must therefore be regarded as not only endowed with the functions of absorption, nutrition and secretion but also with that of sensation." That a tissue thus highly organized is liable to inflammation I do not think is to be questioned.

If it be admitted, and I think it cannot be successfully denied, that the dentine is liable to inflammation, then the question comes: under what circumstances is it likely to occur?

Among other exciting causes of inflammation enumerated in the chapter on that subject, introductory to "Cooper's Surgery," is mentioned "the application of innumerable irritating substances to parts." The agents in the mouth, which produce decay of the teeth, if sufficiently powerful to cause decomposition of the dental bone, which they do, cannot but be of an exceedingly irritating character. As the dental bone possesses all the vital qualities which render it liable to inflammation I cannot see why it should be expected to escape when exposed to the same influences which produce such an effect in other tissues of the body.

That this is really so, many phenomena of frequent occurrence, coming I suppose within the observation of every dentist in practice, clearly convince me.

This sensibility of the teeth is believed by many practicing dentists, at the present day, to be merely their natural sensibility.

If this were so, we might look for some uniformity in this condition of the teeth. We might at least expect to find the same degree of sensibility in all the teeth of the same individual; or if it be admitted that some of the teeth are endowed with a greater degree of vitality, which has been attributed to the incisor teeth, we might, at least, expect to find a higher degree of sensitiveness in these than in any others. But such is not the

fact. And experience shows that in the mouth of the same individual, whilst some of the teeth are extremely sensitive, others, neither more nor less decayed, and of the same class of teeth, are scarcely at all sensitive.

If this extreme degree of sensibility of the teeth is truly their normal condition, we should expect to find in all cases the more nearly we approach the pulp cavity, an increase of sensibility. For no one will, I presume, dispute the principle that the natural sensibility of any part is in exact proportion to its degree of vitality; and we know that the nearer we approach the dental pulp the more vascular do we find the dentine. But we do not find the bone of a decayed cavity in all cases more sensitive as we approach the pulp, but often observe that the most sensitive part may be most distant from the pulp cavity; and it is a fact, which has been repeatedly stated, that if in some cases a layer of sensitive bone is cut rapidly away with a sharp instrument, the sound bone underneath will be found almost, if not entirely, insensible. This is exactly the reverse of what we should reasonably expect if the cause of this sensibility here mentioned were the true one.

It will sometimes be found that the cavity of a tooth very slightly decayed is so sensitive, that the lightest touch of an instrument, or a piece of cotton or lint brought into contact with it will produce the most violent pain. Whilst I know that the teeth, in a healthy state, are endowed with some sensibility, still I cannot believe that that which is here described is their natural condition.

It will be observed that when a cavity slightly decayed is prepared for filling, and the cavity is left open for twenty-four hours or longer, that the sensibility of the part is greatly increased; and I have noticed, too, that sometimes the bone of a cavity which is not at all sensitive, if left exposed, after having been prepared for filling, to the contact of the fluids of the mouth, it becomes, after a time, highly sensitive. I do not see how these facts can be accounted for on any other hypothesis than that which I have advanced.

At the time of writing, a well marked case of this kind has just occurred in my practice.

CASE I.—Mrs. C. aged about thirty-five. I had occasion to prepare for filling, amongst others, a cavity situated in the anterior lateral surface of the second left superior molar. The first molar was absent. The cavity was neither large nor very deep, and required considerable excavation; this produced no pain of consequence, not sufficient to induce the patient to speak of it. When the cavity was prepared, it so happened, that I was unable to complete the operation at that sitting. It was some days before I was able to see the lady again, and I then found the bone of the cavity so extremely tender, that it gave her great pain when I attempted to dry out the cavity, and I was obliged, or at least as it was in my power to accomplish it I preferred doing so, to remove this tenderness of the part before completing the operation.

On the other hand if a highly sensitive cavity is filled with any substance, so carefully as entirely to exclude the fluids of the mouth, this sensibility will after a time pass away, as is shown in the following case, which is one of by no means rare occurrence.

CASE II.—April 21, 1851. Miss H. aged about fourteen, came into my hands a year ago. Most of her teeth requiring attention were more or less sensitive, and she suffered much pain in the course of the performance of the necessary operations. The right superior lateral incisor was decayed, not very deeply, on the anterior lateral surface, but it was extremely sensitive, and with all her efforts, she could not bring herself to bear the perfect preparation of the cavity. After preparing it, however, as well as I could, I endeavored to fill it with gold, but found that the attempt caused so much pain that I desisted, satisfied that, if continued, the operation would result in the destruction of the vitality of the pulp. I then determined, to accomplish the object above indicated, to fill it temporarily, and tried gutta percha for the purpose. This, however, owing to the small size of the cavity, would not answer, although I am inclined to believe that in many cases it might be found

useful. I then filled the cavity with tin foil, which with care, I succeeded in doing tolerably well. To-day, after the lapse of a year, she called on me again, as I had directed her to do. I removed the tin filling which was much firmer than I supposed it to be, and found that the sensibility of the bone, which was so extreme when I filled the cavity, had now almost entirely passed away. I had no difficulty in perfectly preparing the cavity for filling, although I cut down below the surface of the bone. I then filled it permanently with gold. There is another point about this case of importance. When the cavity was filled a year since, in the imperfect manner in which I was obliged to do it, the decomposed bone was not entirely removed, but a considerable portion of light colored caries (a species which, it is well known, proceeds with rapidity) was left, owing, as I have stated, to the extreme tenderness of the part; on removing the tin filling and examining the cavity, carefully, I could not detect the slightest change in its condition. If the caries had progressed at all, it had been so slowly, and to such an inconsiderable extent, that it was inappreciable. I shall subsequently refer to this fact.

Now, in this case what seems to have occurred; I not only cut away the external layer of bone which might have been supposed to be deprived of its vitality but I cut down to what must have been living bone, and found only a very slight degree of tenderness, and none of that exquisite sensibility which a year ago prevented me from operating well. I am satisfied that the bone, protected from the action of the extremely irritating agents which were rapidly destroying it, and producing great inflammation of the part, recovered its natural healthy condition.

I have intimated above that I feared, if I had persisted in filling the tooth in the case mentioned, that I should have run the risk of destroying the vitality of the pulp. And this result, sometimes following the operation upon a tooth in this condition, shows the propriety of considering this sensibility of the dentine in connection with the treatment of the dental pulp. I have found, as the following case will show, that the pulp is some-

times destroyed either by the pressure of a firm filling, well compacted, or the irritation attendant upon the preparation of the cavity. And I am inclined to believe that a good many of those cases we meet with so commonly, of teeth in which the pulp is dead whilst they are but slightly decayed and filled, are to be attributed to the same cause. I have often closely questioned persons who have had teeth in this condition, and have been satisfied from what I have gathered from them that, at the time the teeth were filled, the pulp could not have been even slightly exposed. My own experience confirms me in this view. I have generally been very cautious in all such cases. Sometimes treating them as the one above detailed, and sometimes taking measures first to remove this excessive sensibility, and consequently few such results as that recorded in the case below have occurred in my practice. I do not mean to be understood as implying that consequences of this kind are likely to occur in a majority of cases where this sensibility exists, but I am satisfied that they do occur probably more frequently than is generally suspected.

CASE III.—Mrs. L. Aged about thirty-five. First left superior bicuspid-crown and posterior lateral surface. This tooth I found slightly decayed at the places above indicated, but so extremely sensitive that it required the greatest effort on the part of the patient to bear the necessary excavation. As, however, she was willing to bear the pain attendant upon the operation, I completed the preparation of the two cavities. Fearing, from the extreme tenderness of the cavities, that the pulp might be slightly exposed, I now most carefully examined them in every part, and satisfied myself that this was not so. I then proceeded to fill them with gold, a good deal of pain was experienced during the performance of this part of the operation, but not more than I have many times observed in similar circumstances. After the fillings were completed, no pain was complained of, and the patient went away quite satisfied to have got through with so painful an operation. After the lapse of some days she called again, and complained of having suffered some pain with this tooth. I examined it, and to my sur-

prise found that an alveolar abscess had formed above it. I intended removing the fillings and extirpating the pulp, but I did not have an opportunity of doing so.

In this case I know perfectly well that the pulp was not exposed, even very slightly. The caries was by no means deep, not extending I am quite sure half way through the dentine, and if it had not been for the very great tenderness of the cavity, I should never have thought it necessary to examine to see if the nerve was exposed. But supposing it possible I did make a most careful examination before beginning to fill, and quite satisfied myself that there was no opening into the pulp cavity. This it seems to me was a clear case of inflammation of the bone, extending to the pulp, and the unfavorable result was caused by the great irritation consequent upon the excavation of the cavity and the pressure of the gold filling, which, of course, was inserted with much force, upon the inflamed bone.

Careful attention to the symptoms attendant upon the progress of caries of the dentine, furnishes, to my mind, strong evidence of the position I have here taken. I have had the good or bad fortune to be able to study this subject in my own particular case, and whilst my sound teeth are as insensible as those of any other person, those which have begun to decay, furnish me, by sensation, with unmistakeable evidence that they are diseased. I am aware, at times, of a sensation in them, not exactly a painful one, but a faint consciousness of the form and position of the decayed cavity. My attention has frequently been called by patients to teeth which they had an impression were decayed, although they had never caused pain nor exhibited externally any evidences of decay. I never neglect on receiving such a hint, most carefully to examine the teeth indicated, and rarely, if ever, find them sound and healthy. This impression of a sensation is produced, I do not doubt, by the compression of the inflamed and swollen animal portion of the bony tissue, in a manner precisely analogous to what occurs in tooth-ache in the pulp itself. Dr. Maynard informs me that he has been conscious of the same sensation under similar circumstances.

In the lecture on dental caries in the admirable treatise on "Dental Physiology and Surgery," by Mr. Tomes, republished in the "Journal," I find, since writing the above, the following paragraph corroborative of the statement just made.

"The diseased action is not attended by severe pain, but I am disposed to think that even early in the disease, there is, in almost all cases, a feeling of slight uneasiness in the affected tooth, though the degree may be so slight as to escape detection at the time, or lead only to the supposition that some foreign matter has got between the teeth. I am induced to adopt this opinion, though at variance with several authors of distinction, both from the description given by patients who have suffered from caries, and also from personal experience in this unpleasant malady. On several occasions my attention has been drawn to a tooth by a sensation not perhaps amounting to pain, but to slight discomfort only, which lasted but a few minutes. After a recurrence, from time to time of this unpleasant sensation, I have examined the tooth, and have invariably found that caries had commenced in the situation from whence the uneasiness seemed to proceed." Mr. Tomes' experience seems to have been precisely my own.

There is a great difference in different individuals with respect to the sensibility of teeth affected by caries. Whilst many suffer the most agonizing pain in having operations performed upon their teeth, many suffer so slightly as to render it a matter of indifference, and others do not experience the slightest painful sensation. I have noticed that in cases where the caries is of soft consistence and light color, denoting rapid decomposition of the part affected, great tenderness of the bone is present, and on the contrary, when the caries is of a dark color, and progresses slowly, that there is but little tenderness of the affected part. This, however, is not invariably the case, but I have observed it generally. The explanation of this difference must, I think, be found in the fact, that in one case the chemical decomposition of the bone, produced by agents which do not in the same proportion destroy the animal portion, goes on so rapidly that the death of the vital part does not take

place simultaneously, but is previously thrown into a state of great inflammation; in the other case, where the disease progresses slowly, the entire death of the whole bone occurs.

I have observed that in the teeth of the same individual there is a difference in degree of this sensibility at different periods of life. I have now in my hands, a lady about twenty-eight years of age, upon whose teeth I have operated since she was a girl. Before her marriage, her teeth were generally as little sensitive as those of any other person. At this time she has been married several years, and has had two children. Her teeth, when decayed, are now extremely sensitive.

It is a well known fact, that in some cases, if the bone for a little distance below the decayed surface of a very sensitive cavity be cut away with a sharp instrument, it will be found but slightly tender, and the operation may be continued with but little pain to the patient. Now, it seems to me, that no clearer evidence of a change in the condition of the bone could be asked for than this; for if this sensitiveness were only the natural sensibility of the tooth, it would of course not grow less as you approach the more vital parts of the tooth, but would with reason be expected to increase. What we understand by inflammation, is such a change in the condition of the part as will fully account for the fact here mentioned. The irritating agents causing decay, have excited an inflammatory action in the portions of bone exposed to its contact, without affecting such portions as are beyond its reach, and as soon as this outer layer is removed, we reach bone which only exhibits its natural degree of sensibility.

It is not always the case, however, that the removal of the carious portion and the layer of bone immediately adjacent to it will have the effect just mentioned; but this extreme sensitiveness may continue till the operation is completed. This may be accounted for on the supposition that the contact of the carious bone has excited so high a degree of inflammation that the whole body of the dentine is affected.

Other facts going to confirm the opinion that this great sensitiveness of the carious dental bone is due to inflammation of

the part, might be mentioned, but this I do not think necessary. If those already presented are not as convincing to others as they have been to me, I should be glad to have them explained, for I must confess that I have never been able, nor am I yet so after thinking a great deal about it, to find any other satisfactory explanation than that which I have just given.\*

It may be said, that the discussion of this question is a matter of very little practical importance. I do not think so. If my position is tenable, it may, as I have stated, account for instances in which the destruction of the pulp has occurred, after an operation, long before it has become uncovered, and it must lead to other practical considerations of importance. Besides, it is often seen that the discovery of truth, in relation to the causes of any morbid condition of the system, leads to practical results which were never before anticipated. This remark, indeed, holds good with regard to the proper and thorough scientific examination of every subject. A discussion of this kind, based upon observation, is a very different thing from the practice, not uncommon, of erecting an elaborate theoretical structure, which cannot be applied to any useful purpose, upon a very slender foundation of facts.

But whatever may be the real cause of the condition of the teeth here alluded to, and about which I have said more than I intended, it is one of the most serious obstacles to good practice with which we meet; at least I find it so. And I know that some skilful members of the profession, with whom I have conversed on the subject, have found it equally so. It may be a great weakness to allow the knowledge that you are inflicting severe pain in performing an operation to disturb your equanimity, and in any way interfere with the perfect accomplishment of what you know is intended for the ultimate good of your patient; but it is a weakness I have found it very difficult to overcome. Although I make it a rule, in this as in every other case, to do my best, regarding, as little as possible,

\*Since writing the above, I have read an article in the "American Journal of Dental Science," by Dr. E. Townsend, of Philadelphia, in which I am gratified to find, he takes the same view which I have just presented.

the pain inflicted, if it is necessary, I must confess, that I am so anxious to get through with so unpleasant a task, that I am apt to stop in the preparation of a cavity, which I *think* it will answer, without always being certain of it. Gentlemen who have alluded to this subject, have generally treated it lightly, making some passing remarks about it, and stating that a few bold strokes, with a sharp instrument, will end the difficulty. In some cases, as I have already said, this is so; but not, by any means, in the greater number. I may, perhaps, give more importance to this matter from having known something of it from personal experience. My own teeth are very sensitive, and I do assert, for those who have never had the benefit of such experience, (to those who have had, I am sure no such assurance is necessary,) that the preparation of a decayed cavity for filling, when the bone is inflamed, is one of the most agonisingly painful operations that I have ever undergone. It is a peculiar, indescribable, unendurable sort of pain, very different from that produced by the incision of the skin or of muscular tissue. These cases are far from being exceptions. In the course of practice I frequently meet with persons who seemed to suffer the most dreadful agony from this cause. That this experience is not peculiar to my own practice, the following extract will show: "A few cases are met with, in which there is considerable pain attending the progress of caries long before the pulp is at all affected by exposure, or by the contact of partially decomposed dentine. The tooth is, from the commencement, highly sensitive: the contact of hot or cold fluids induces severe pain, and may attempt to remove the carious dentine, though the disease has existed but for a short time, and is very slight in extent and depth, *produces such unbearable pain, that the attempt is for the time obliged to be abandoned.*"—Tomes, Jour. vol. viii, 211. In many of these instances, this exhibition of suffering could not be attributed to a lack of firmness, as the following case, I think, will prove:

CASE IV.—Some six years ago, my services were desired by a lady whose teeth were in such condition that they were, with the exception of the inferior canine and incisor teeth, past the

hope of preservation. These were slightly decayed on their lateral surfaces. The patient in question had never had any teeth extracted, and at three sittings they were all removed, with the exception of those just mentioned. It was determined that these should be filled. She bore the operation of the extraction of her teeth, some of which were very difficult to take out, with stoical firmness. After the mouth had healed somewhat, I proceeded to prepare the cavities in the remaining teeth for filling, and found them extremely sensitive. She shrunk at once from this pain, and after I had completed one cavity and had begun another, she declared she *could not* bear it, and insisted on having the teeth extracted. As their preservation was not a matter of much importance, and as I then knew of no safe means of removing this sensitiveness, I complied with her request. This is a strong case; but I have repeatedly met with patients who have declared that if it were not for the loss of the teeth, they would infinitely prefer to suffer the pain of their extraction, than to endure this horrible torture.

Now, the operation of the extraction of teeth, even with the present greatly improved instruments in use for the purpose, is an exceedingly painful one, and probably as much dreaded by most persons as any kind of surgical operation to which they could be obliged to submit. And, I think, it will be admitted that the operation which exceeds this in the intensity and duration of the pain it causes, even if it be only in the imagination of the patient, is well worthy of our most earnest efforts to find a remedy for the evil. It is a plain duty, and it ought to be a source of great pleasure to every one, to do all in his power towards the alleviation of human suffering; and there is no field in which he may labor more profitably for this purpose than in this one. For when the vast number of operations on the teeth, which we daily perform, are considered, it seems probable that the aggregate of pain inflicted, is greater than occurs in all the practice of general surgery. This, indeed, would be certain if all persons who are obliged to submit to operations on the teeth found them in the condition just described, for whilst a large proportion of the people composing our communities

now give attention to their teeth, a comparatively small number are subjected to surgical operations.

But, however regardless a practicing dentist may be of the pain he inflicts, or however steadily and coolly he can go on to the completion of his operations, when he is aware that his patient is in an agony of suffering, there are other considerations which render an effort toward the lessening of this evil, an important matter to him. Although some persons who come into his hands have nerve enough to bear any operation upon their teeth, no matter how painful it may be, without flinching, there are others who cannot bear it steadily, and some who cannot, or will not, bear it at all. And it is easy to perceive, that any thing like a perfect operation is out of the question, when the patient is shrinking from, and writhing under, every touch of an instrument.

The very great dread of dental operations exhibited by children, is to be attributed principally to this cause; wholly, indeed, with the exception of the extraction of teeth; and I have met with children who could not, by any means, be induced to submit to the operation of filling their sensitive teeth. I remember one case, in which the little fellow who made a great effort to bear the pain, sobbed so violently at every attempt I made to prepare a cavity in one of his teeth, that I was obliged to desist. And at this time, the case of a little girl, not more than seven years of age, for whom I found it necessary to fill the first permanent molar teeth, comes into my mind. She sat perfectly still whilst I was operating, but the big tears rolled down her cheeks during the whole time, giving such touching evidence of what she was suffering, and of the firmness with which she bore it, that it was no little relief to me to have completed what I felt obliged to do for her.

Now it will be seen, that if a certain and safe remedy for this be found, it will not only render our profession less formidable, but will enable us to perform more perfect operations. It must be plainly seen, too, that it will greatly increase the aggregate amount of business, and contribute largely towards the cause of humanity by extending the sphere of our usefulness; for many

persons who cannot now be induced to avail themselves of the benefits of our profession, in consequence of their invincible dread of the pain they are obliged to endure, would gladly do so if they could escape some portion of it.

This matter has engaged my earnest attention for a number of years, ever since, indeed, I have been in practice, and I have not failed to make trial of every thing which has been suggested by others, or which has occurred to my own mind, for the purpose indicated; but until within a few months past without satisfactory success.

I have tried faithfully, the mineral acids, the caustic alkali, nitrate of silver, tannic acid, chloride of zinc and even the actual cautery.

Chloride of zinc, which I first used about seven years ago, and applied for experiment in a variety of ways, did not at all come up to my expectations. In the first case in which I used it, the result was so strikingly successful that I was satisfied that the desideratum for which I had been looking, had at last been fallen upon. But I subsequently found that, from causes which I could not discover, it was so extremely uncertain in its effects, not answering the desired purpose once in twenty times, and gave so much pain when applied, that I abandoned its use. I gave it a faithful trial, and was reluctant to give it up, for I felt convinced, from its peculiar escharotic properties, that it was just the agent which would answer fully the purpose of destroying the vitality of the part with which it was placed in contact, without extending any further. I perceive it stated in the last number of the Journal, by Dr. E. Townsend, of Philadelphia, that he uses it with success, by allowing it to remain half an hour in the sensitive cavity. I certainly still believe it well worthy of further trial.

Till within a few months, the only substance of which I knew any thing which would, with uniform certainty, remove this sensitiveness of the dental bone, was arsenic. But there are serious objections to this agent for the purpose in question, and it could scarcely, with safety, be recommended for general use. When applied to a tooth considerably decayed, or allowed to

remain any considerable length of time in a *very* superficial cavity, it is likely to pass in a state of solution through the substance of the bone, to the pulp, and ultimately destroy the vitality of this part of the tooth. This result, so liable to follow its application, has driven arsenic, for this purpose, out of general use. It has been asserted that arsenic cannot be applied to any tooth, in any stage of decay, without eventually causing the destruction of its vitality, even after the lapse of years. This is supposed to occur from the impossibility after it is once applied of removing every particle of the substance from the cavity, and that, however minute the quantity which remains, it will at last find its way to the pulp. But this assertion I know, from actual experience, to be like many other sweeping assertions occasionally made, as well in our own as in other professions, to be unfounded in fact. I have used arsenic occasionally for the last ten years for this purpose, and have never in any case, when I applied it with proper precaution, and my directions were carefully observed, had bad results. Cases I know now of seven years standing where the teeth are as healthy as any in the mouth. But it is unnecessary to urge the claims of this substance, for the purpose in question, or to give any particular directions about its use, for I have another agent to offer which entirely supersedes the necessity of using it in any case.

This is the ore of cobalt. My attention was first called to this mineral, for the purpose of destroying the vitality of the dental pulp, by Dr. Hunter, of Cincinnati, in a conversation with him last summer in Philadelphia. Dr. H. did not claim it as a discovery of his own, but said he had accidentally fallen upon it, and that it had been used in the west long before he knew any thing of it. I have since used it exclusively for destroying the vitality of the pulp, and latterly with very satisfactory results, for removing that sensibility of the bone which has formed the subject of this chapter.

The active escharotic properties of the ore of cobalt is undoubtedly due to the arsenic which is always found combined with it in large proportions. Some kinds of this ore contain as

much as fifty-five per cent. of pure arsenious acid. But the peculiar advantage of this substance is, that it is insoluble in the fluids of the mouth, whilst the arsenious acid is readily soluble. The importance of this difference between the two substances, is obvious. The danger of using arsenic in the cases of which we are now treating, arises from the fact, that it is soluble in the fluids of the mouth and, in a state of solution, as we have already said, will rapidly pass through the substance of the bony portion of a tooth, when placed in a cavity, and reach the pulp; this it will certainly do, if allowed to remain long enough, no matter how thick or dense the layer of bone may be which covers the pulp. It has been said, and I doubt not with truth, that if an opening is made through the enamel of a sound tooth and a small quantity of dry arsenic is placed in it, that it will eventually destroy the pulp. Now, although I am unable at present to demonstrate that the particles of pulverised cobalt cannot pass through the substance of the dental bone, I think it was doing no violence to strong probability to suppose that it could not, and felt justified in making experiments with it. The animal matter of the bony substance is small, and does not, under ordinary circumstances, admit the corpuscles of red blood, which have (see Carpenter's Physiology, p. 120) the minimum diameter of 1.2800th of an inch. It is scarcely probable, as I have said, that the particles of cobalt in a pulverized state can be so minute as to pass through a substance which excludes the smallest corpuscles of the red blood.

The inferences drawn from actual experiment in the use of cobalt for the purpose indicated, and a comparison with the effects produced by the arsenious acid in similar circumstances, justify strongly such a conclusion.

The following is one of several similar cases which have come into my hands:

CASE V.—January 10th, 1851. Mrs. A. aged twenty-seven; nervous temperament. Found first left inferior bicuspid badly decayed on the anterior lateral surface. Examined closely and found decayed very nearly to the pulp, although this was not actually uncovered at any point. On attempting to prepare it

for filling, found the bone of the cavity extremely sensitive, and the patient, who did not lack firmness, declared after several efforts, that it was entirely out of her power to bear the pain necessary to prepare it for filling. She begged me to extract the tooth at once and let the matter be over. I found I could do nothing, unless by some means this sensibility could be removed, and I regarded it as quite justifiable to attempt it, even at the risk of destroying the pulp. I had used cobalt for destroying the vitality of the pulp, had thought a good deal about its action in such a case as this, and determined to make a trial of it. I mixed a small quantity finely pulverized, with gutta percha, softened by the lamp, and filled the cavity with it. This I allowed to remain twelve hours. At the end of this time I removed it, and found the sensibility of the cavity scarcely at all diminished. Confident that it must destroy the vitality of the bone with which it was placed in contact, I again applied it, and allowed it to remain twenty-four hours. On its removal, I found the bone still sensitive, but remembering from some experiments with arsenic, for the purpose, that the sensibility of the bone is always at first exalted by the action of the material, but subsides in some hours after its removal, I determined to wait a little while before making another trial. About forty-eight hours were now allowed to elapse before I made another examination, when I found so little of the sensibility remaining that I was enabled to complete the operation with scarcely any inconvenience to the patient.

Now, if arsenious acid had been used in this case, I know well, from the experience I have had in its use, that in one hour it would have reached the pulp. The symptoms produced would first have been a dull sensation of pain, and if the arsenic had not been removed at once, would have increased in violence till tooth-ache, of the worst character, would have set in. If it had not produced any immediate effect of this kind, it would certainly have occurred in a few days.

That the cobalt, in this case, did not produce any effect upon the pulp is evident, from the fact that no kind of uneasiness followed its application, although it remained in all, in contact

with but a very thin layer of bone between it and the pulp, some thirty-six hours. But if this is not sufficient, the subsequent condition of the tooth fully proves, I think, the fact, that its vitality is unimpaired. Some four months have now elapsed since the operation was completed, and there has not yet occurred the slightest symptom indicating any change in its condition. I have examined it carefully, and repeatedly, and have not yet seen the least indication of peridental inflammation or anything which would induce me, for a moment, to believe that the pulp had been touched.

This, as I have stated, is but one case out of several of precisely the same character.

The cobalt ore will, undoubtedly, uniformly remove this extreme sensibility of the dental bone; and the only question as to the propriety of its introduction into general use in practice is: can it always be used with safety, without lessening the chances of the ultimate preservation of the teeth? This is a question which I cannot yet venture, with confidence, to answer affirmatively. In the course of my experience I have met with many things which at first sight promised a great deal, and which were eventually shown to have objections almost, if not entirely, neutralizing the good results expected from them. This may be the case with the agent I now offer. The advantages which in my hands have attended its use, almost seem to be too great not to have some drawback. But I am satisfied, that even if it do not fully meet my expectations now, it will be found a valuable acquisition to the practice of dental surgery. I can only say to every member of the profession disposed to make a trial with it, to do so cautiously and with discrimination, and time, alone, must test its real value.

The only unpleasant result I have yet observed in its use, so far, is, that in some cases slight peridental inflammation has occurred. What renders this unaccountable, is, that I have always observed it to occur, when it did occur, which has probably not been more than in six cases out of a hundred, in quite superficial cavities, and never, that I now recollect, in any case of considerable decay, where it might have been expected. It is

quite impossible to account for this result by supposing that the cobalt could have, by any means, passed through the thicker and denser body of bone in these cases, when it did not do so when placed in a cavity where there was a much thinner wall of bone to protect the pulp, and this, too, of a character (the fibres being more direct and not so tortuous, according to Nasmyth) much more likely to favor the transmission of any substance which could pass through it than the bone nearer the enamel.

I have applied it in several ways, and have observed some difference in the results corresponding to the manner of its application. I found it by no means so active when mixed with wax, as I once used it, the wax coming probably between the cobalt and bone, and preventing direct contact.

The most convenient and effective method I have fallen upon to apply it, is to dissolve sandarach in alcohol, saturate a piece of cotton in the solution, and take upon it as much cobalt as is necessary; about the twentieth part of a grain is sufficient. Enough cotton should be taken to fill the cavity. When pressed into the cavity, the superabundant liquid must be wiped away, and enough will be left to cement the fibres of the cotton and form a very substantial temporary filling. This will make it easy to apply the cobalt to the most shallow cavities, as the cotton saturated with this preparation will readily stick to the surface to which it is applied.

When the cavity is so deep as to give occasion for any fear of its action upon the pulp, I have always regarded it as safer to apply it with gutta percha, by softening this substance and working the cobalt into it. Even if it be possible for the particles of cobalt to pass through the substance of the bone, this would effectually prevent it; for the gutta percha is perfectly insoluble in the mouth, and whilst it would hold the cobalt in contact with the affected part, would not allow a single atom to escape from its grasp. It is used, as any one will know, who has used gutta percha for any purpose, by softening the gum in a lamp and pressing it into the cavity. Gutta percha dissolved in chloroform, might answer a better purpose than the sandarach mentioned above; I have not tried it, however.

In using the cobalt for this purpose, I generally allow it to remain from twenty-four to forty-eight hours. If the cavity is deep, I remove it in twenty-four hours, and fill in twenty-four hours afterwards. I have generally found, in removing it, after it had remained only this long, that the sensibility of the part was not much diminished, but would be found entirely gone, if the same time were allowed to elapse after its removal before the preparation of the cavity was attempted. I have observed, as I have already mentioned, in the use of arsenic, for the same purpose, that in removing it, after it had remained two or three hours, the sensibility of the part would be found rather exalted than diminished; but, that the next day scarcely a trace of it would be found remaining. In bringing about the death of the bone, the inflammation of the part to which it is applied, is, of course, at first increased. But if the cobalt is allowed to remain forty-eight hours, no trace of the sensibility complained of will generally be found to remain. Whether it is always safe to do this, must be a matter for future observation; I can scarcely think any risk attends it, for in slight cavities, on one or two occasions, I have, in consequence of failure of the patient to come at the time appointed, allowed to remain a week without observing any bad consequences.

### CHAPTER III.

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I PROPOSE now to consider those cases in which the caries has passed that point when it can be removed, in the performance of the necessary operations to arrest its progress without danger of injury to the pulp; or after it may have begun to exercise some injurious influence upon this part of the affected tooth.

The principal portion of these papers will be devoted to a discussion of the propriety, in certain cases, of the entire extirpation of the dental pulp, and the best means of effecting this object. And although I shall endeavor to show that this practice, in certain cases, may be pursued with great advantage, I am quite willing to admit, what, indeed, I could not deny, that when the pulp can be preserved *untouched, in a healthy condition*, it is always better that it should be done. No effort, indeed, should be spared to accomplish this most desirable object.

In treating this part of my subject, I shall present views at variance with those generally entertained in relation to it, in the profession; views, however, the correctness of which can, I think, be clearly established, both by sound reasoning, and by facts. Although I am not aware of any publication which will bear me out in the position I am about to take, I am gratified to know, from private intercourse with some of the most intelligent members of the dental profession, that my opinions in this regard are not peculiar, and that if I am not sustained by them to the full extent to which I propose to carry them into practice, still I am so to an extent far beyond what has ever been sanctioned by any writer upon dental surgery, at present known to me.

I deny, positively, the truth of the statement so often made, that caries of the teeth will always continue to progress, after it has once set in, unless every particle of the decayed bone be removed from contact with that which is healthy. I do not believe that, when the cavity of decay is so filled, as absolutely to prevent ingress of the fluids of the mouth, that the disease ever advances; although my observations upon this point are not sufficient to furnish me with decisive proof that it is so. But I do affirm, with confidence, that a series of observations, running through a practice of ten years, have convinced me that in a vast majority of cases, caries of the teeth remains stationary, if the opening of the cavity of decay is well prepared and the cavity so filled as to exclude every thing from it, although decayed, dead and decomposed bone be left in it.

This opinion is not advanced in a spirit of self-confidence, or for the vain purpose of endeavoring to gain reputation by presenting a novelty. I state it, and shall endeavor to establish its truth, because, as I shall show, if grounded in fact, it must have a most important practical bearing.

What is the true pathology of dental caries?

After a great deal of discussion of this question, extending over a number of years, the settled opinion at the present day is, that caries or decay of the human teeth, is a decomposition of the dental substance, caused by the action of a chemical agent formed, in most cases, in the mouth, and brought into, and retained in contact with certain parts of the teeth; its action modified by a variety of circumstances, more or less perfectly understood. I believe that this view of the nature and cause of dental caries is not now controverted.

How, indeed, can it successfully be? It is known, to demonstration, that certain kinds of acids are capable of decomposing the earthy bases entering into the structure and forming a large part of the dentine and enamel of the teeth. It has been repeatedly demonstrated that such an acid is present in the mouth of many, if not of most persons. And it is known that in cases where decay has begun, and would inevitably go on, (as, for instance, on the proximate surfaces of the teeth,) if such a change

is made in them as to prevent the continued retention of the destructive agent, decay will cease to advance.

It is then, a fact, so well established by long and general observation, that I think I may take it for granted, that the exciting cause of decay of the teeth is external, and that the destructive agent, whatever it may be, is in the mouth, and exerts its influence upon the teeth, by being retained in contact with certain parts of them. Its action is, of course, modified by the original structure of the teeth.

If this be admitted, the only question having a bearing on this discussion is : Do any new elements enter into this destructive process, after it once begins, rendering its progress independent of the original cause ?

I have examined, carefully, all the works on dental surgery within my reach, but find nothing in them to assist me in this inquiry. This, I believe, has never been made a subject of special investigation, and all the inferences drawn from the presentation of the general subject of caries of the teeth, point in an opposite direction.

In an extensive intercourse with intelligent members of the profession, I have frequently introduced this subject, but have not yet heard a distinct suggestion at all satisfactory to me, as to the manner in which caries of the teeth could progress, except by the action of some external solvent.

The only way, within my knowledge, that it has been attempted to be accounted for, with any show of reason, is upon the old hypothesis of inflammation of the dentine. Now, it has many times been most conclusively shown, that in the commencement, at least, inflammation of the dentine is not the cause of caries. And even, if it may be supposed that decay is kept up, after having once set in, from this cause, in what manner could carious bone contribute to this result ? I am not aware, that decayed dentine has been supposed, by any writer worthy of consideration, to contain any particularly corrosive qualities ; and, if it is only inorganic matter, which it must be—simply, dental bone deprived of its vitality—I am unable to conceive of the manner in which this could serve to keep up

the inflammation of the part with which it is in contact any more than the materials used for filling, which are equally inorganic. It may be objected, that the carious bone will contain some of the solvent agent in union with it, and that this is sufficient to promulgate the disease. But, it must be seen that unless a further supply were furnished, this would soon exhaust itself and become neutralized.

If it were true, that inflammation of the dentine is a sufficient cause for the continuance of its decay, then the only means of arresting it of which we know any thing, would prove worse than useless, for the direct contact with the living bone of a metallic substance, being, as it is, so good a conductor, would tend to keep up irritation instead of allaying it.

But, even if it be granted, which I do not grant, for facts show conclusively that it cannot be so, that decayed bone left in the cavity of decay could excite inflammation of the adjacent bone, I cannot conceive how this would bring about a condition of things bearing any resemblance to what occurs in the progress of dental caries. It might possibly cause death of the part; but, if after that, its decomposition could occur, I have observed no fact which would justify me in the conclusion, that the absorbent vessels of the tooth have sufficient capacity to remove the decomposed bone.

Mr. Tomes, in his account of the causes of dental caries, supposes it necessary that the dentine should first be deprived of its vitality before it can be acted upon by the decomposing agent. But, although he makes the death of the part an essential preparation for the action of the solvent upon it, he makes the decomposition of the dental tissue absolutely and invariably dependant upon a solvent agent. How far he may be correct in his position, in relation to the deprivation of the dentine of vitality previous to the occurrence of decay, I will not now undertake to examine. It is probable, that destruction of vitality does take place before decomposition, but the agent causing the decomposition of the part is, in itself, capable of destroying its vitality, and, in my opinion, generally does so. Mr. Tomes, however, attributes this loss of vitality, in many instances, to

constitutional causes acting independently of the agent producing the caries, and preparing the way for it.

A great deal has been said about the removal of the dead and decomposing dentine, in performing the operation of filling, and the necessity of cutting down to that which is sound and healthy, so as to allow no contact between the dead and living bone. But, it must not be forgotten, that the surface of the bone which is cut away, no matter how sound and healthy it may be at the time of the operation, cannot be treated in this manner without injury. Such violence as cutting across a living part cannot be done without injury to its vitality, and if injured, we know that the dentine has no power of recovering itself, and, at last, it must be seen that the surface of the cavity next the filling is dead bone, or bone partially deprived of its vitality.

If this be true, it is evident that the simple death of a part of the bone cannot produce decay in an adjacent part; for if it were so, the operation invariably resorted to for the arrest of this disease, instead of being perfectly effectual for the purpose, as it is found to be, would be the very means of propagating it more rapidly, for the death, or partial death, which amounts to the same, of a considerable part of the bone, is the invariable result of the preparation for filling of every cavity.

Judging, therefore, from a consideration of the structure of the teeth, the low degree of their vitality, the only means of which we know anything by which their decomposition is effected, I cannot but conclude that dental caries, as commonly known, is invariably caused by the action of some solvent agent, retained long enough in contact with the bone to effect its decomposition, and that if the contact of this destructive agent can be effectually prevented, the decay cannot go on.

I am most decidedly confirmed in this opinion, by all the facts having any bearing upon the matter, which have come within my practice for a number of years. Many of these instances must have been met with by every one engaged in the practice of the profession.

A fact well known, although trifling in itself, goes a great way to establish the position I have taken; indeed, I am un-

able to see how such evidence can be set aside. I allude to the fact, that if a deposit of tartar takes place in a cavity of decay, the destructive process is most certainly arrested. The late Dr. Hayden, I well remember, was in the habit of saying, that if he found a decayed cavity filled with tartar, he never touched it, for the preservation of the tooth in that condition was quite certain. Now, in this case, nothing has been done toward the removal of the carious bone, upon which the tartar has been deposited—the cavity is in precisely similar condition to one in which a gold filling has been placed upon the carious bone. The objection may be made here, that the character of the saliva, from which the tartar has been deposited, is itself a sufficient reason to account for the arrest of the decay; for the very deposit is an evidence of an excess of alkaline qualities, and it must have neutralized any acid secretion present, and prevented its action upon the bone previous to its deposit. But, this objection only goes farther to establish my view of the case, for it would prove, that as soon as the action of the acid agent is interfered with, the decay is arrested. It may also be said, that there is this difference in the two cases; that the gold placed upon the decayed bone, confines in the cavity a portion of the destructive agent, which is completely neutralized before the deposit of tartar commences. But, it is only necessary again to reply, that the quantity of acid which could in such case be left in union with the decayed bone would be so trifling that as soon as a further supply was cut off it would speedily exhaust itself.

I have conversed on the subject with but few of the better practitioners of our profession, who have not admitted, that, occasionally, they regard it as good practice to leave decomposed bone in the bottom of a cavity when it was very probable, that the removal of this changed bone would lay bare the pulp. By decomposed bone I do not now mean that discolored bone which is so often thrown out by the pulp when threatened with exposure. That this practice is more commonly pursued than is generally acknowledged, I am fully satisfied. In these cases, the caries must have penetrated so

nearly to the pulp, that if it continued to progress with the same rapidity with which it had gone on to this point, a few weeks or at most months, would have been sufficient to have required the removal of the filling, pulp or the tooth, and yet I have not heard the individuals here alluded to, imply that they regarded this as an operation requiring subsequent attention.

I have removed fillings in consequence of their defectiveness, which have been in place for many years, and have repeatedly found what I could not but regard as conclusive evidence, that the caries had not been entirely removed at the time the operation was performed, and yet decay had not progressed in the parts where it might have been expected to go on. It seems to me scarcely possible that this should not have been the experience of every practitioner of long standing.

I have mentioned these things as facts, probably coming within the observation of every practicing dentist. But in addition to these, I have, for several years past, been making experiments with direct reference to this particular object. The results of these observations I will, at some future time, make known more specifically to the profession. These facts, to which I have endeavored to direct attention, although they may not lead every practitioner so far in his conclusions, as they, in connexion with other facts have led me, are sufficient, I think, to establish conclusively this point, which for the present is sufficient for my purpose; that if the cavity of decay is securely filled so as perfectly to exclude the fluids of the mouth, the caries will be materially arrested. I cannot see how, in the face of these well known facts, this can be controverted.

It is now generally admitted, that after the human teeth have attained to their destined length, a deposition of bone from the pulp generally goes on, eventually, in many cases, bringing about its entire obliteration. It is well known that this deposition of bone, from a variety of causes, goes on, at times, more rapidly than it ordinarily does, and sometimes when the pulp is threatened with exposure from decay, is thrown out in such quantity as entirely to arrest the progress of this disease. The

reason why this does not always happen is, that the caries progresses so much more rapidly than this deposition of bone takes place, that the pulp becomes uncovered or brought into contact with the carious bone, and no longer performs this important function. There is no reason to believe that bone is not invariably thrown out from the pulp, and if, when this important part of the tooth is on the point of becoming uncovered, the progress of the caries can be retarded, it is no violent inference to suppose, that, in time, a thick plate of bone will be formed between it and the cavity of decay.

It is well known to the profession, that a tooth may be decayed so nearly to the pulp, that the bone in direct contact with this part, may be in a soft condition without causing any apparent inflammation or even considerable irritation of the pulp. And even in cases where some irritation is present, a degree of inflammation so high as to cause pain, does not occur. There may even be great tenderness to slight pressure, so nearly may the pulp be entirely uncovered, and yet the pulp seem unaffected by disease.

I do not suppose, however, that any portion of the healthy pulp can remain directly in contact with devitalized bone, any more than with any other inorganic substance, without suffering the usual consequences. It seems probable to me, that in those cases where the bone no longer retains its proper consistence down to the surface of the pulp, and no painful symptoms are present, that a new layer of bone has been formed on the surface of the pulp, and has not yet become hard. It may readily be seen that in such a case as this, although healthy living bone may be in direct contact with the pulp, it would not have consistence enough to protect it from injury by external pressure. It is obvious, too, that in the attempt to remove the decayed parts near it, this new bone may be as easily removed as that which is decomposed. Pain is probably rarely experienced except when, by the caries proceeding more rapidly than this protective deposition of bone, the pulp is at last brought into direct contact with the carious bone, or so large a part is left bare as to expose it to the influence of irritating

substances taken into the mouth, or of the atmospheric air. This is a matter well worthy of consideration, and it must be remembered that when directions are given for the invariable removal of every particle of soft bone from a cavity of decay, that bone which has less consistence than the rest of the tooth, may be bone in the first stages of formation.

The principal reason why I am so anxious to establish the truth of the position I have taken, is, that after the pulp once becomes fully exposed, even the smallest point, the preservation of teeth so affected, is, in my estimation, very doubtful, unless the pulp is entirely removed. The treatment of a tooth in this condition, by "capping" the pulp, as it is termed, has been warmly advocated, but I must affirm although my experience in the operation has been very limited, that I do not remember to have been completely successful in the treatment of a single case in this way. In conversations on this subject with skilful practitioners, many of them have stated this to have been their own experience.

Dr. Westcott, *Journal*, vol. vi, p. 112, in a strong article condemning the use of arsenic for destroying the vitality of the pulp, says of this operation, that he has "tried the experiment time and again, and has never succeeded in a single instance."

I have recently had conversations with members of the profession, who, at one time, very warmly advocated this practice, but who now express doubt as to the final result, and advise that it should be practiced with extreme caution.

I have, on the other hand, been assured by Professor Harris, who has practiced this operation very extensively, that he had removed fillings after some time had elapsed, and found the opening, into the pulp cavity, which was quite distinct at the time of the operation, completely closed with a deposit of new bone. Professor H. also states, that he has recently met with several well marked cases, in which the pulp was extensively exposed at the time of filling, but which, on removing the fillings for examination, was covered with bone in various stages of formation.

I am aware that this operation is practiced, and is strongly

commended by other gentlemen of high standing in the profession, in whose statements I have confidence; and I am quite willing to confess, that I may not yet have fallen upon the correct method of practicing it. But I carefully performed the operation in the manner directed, and so long as I am unable to obtain any more favorable results, I cannot recommend the practice.

It may be asked, why not perform this operation, even if there is a slight prospect of success; for even if it fail, you can then resort to the extreme operation of removing the pulp? The objection is this: the preservation of the tooth is endangered by this course; for it will, in many cases, scarcely be discovered that the pulp is dead, until periodontal inflammation occurs, and then the chances of the success of the final operation of the extirpation of the pulp are abridged; for as I shall endeavor to show, in the proper place, the success of this operation depends, to a considerable extent, upon the healthy condition of the pulp and the periodontal membrane at the time it is performed.

It must be admitted, I think, from the evidence in relation to this matter, either that the true method of performing this operation is not generally understood, or that its success is very uncertain. I cannot but doubt the possibility of the pulp throwing out new bone after it is once entirely deprived of that with which it is naturally covered, it must be brought into contact with the atmosphere, and be more or less injuriously influenced by it. My own experience, in relation to this matter, confirms me in this view of the case.

I propose, now, basing this recommendation on the general view of this subject I have presented, that in every case occurring in practice, where there is a probability of exposing the pulp by the entire removal of the decayed bone to allow it to remain, even when necessary, in considerable quantity.

Let us now consider well this class of cases. It is admitted, on all hands, that no matter how carefully performed, there is some uncertainty, slight though it may be, about the final result of the operation, having in view the entire extirpation of the pulp.

Although an invaluable operation in cases where it is absolutely demanded—and such cases present themselves quite often enough—it must be acknowledged to be a last resort. The evidence in relation to the operation of capping the pulp, which I have just presented, shows, I think, that the successful result of this mode of procedure is still more uncertain. Now, admit that we cannot calculate, with any degree of certainty, what will be the consequence of filling a cavity without entirely removing the decayed bone, is it not better, until we satisfy ourselves in relation to it, to make the trial than to go on so far as to oblige us either to perform the operation, difficult, out of the reach of the purses of some of your patients, and somewhat uncertain of removing the pulp, or the still more uncertain one of “capping the nerve.” We know that a deposition of bone from the pulp is slowly but certainly going on; and we have good reason to believe, that if the progress of the caries can be stayed for a sufficient time, a hard and healthy covering to the pulp will have been supplied. I have been endeavoring to show that the operation I propose, if it do not entirely arrest, will certainly retard the progress of this disease; and, even if my treatment of the subject has not been convincing, a trial, at least, when I positively assert what has been my own experience in the matter, is more than justifiable when the object to be gained is of so much importance. We know, in many of these cases, where the removal of soft bone would certainly expose the pulp, that this bone remaining in contact with the delicate structure, produces no irritation, and from all the indications presented, leaves it in a perfectly healthy condition. Now, as I have already stated, it is the opinion of some of those who have extensively practiced this operation of “capping the nerve,” even after it may have become exposed at a very small point, that its success is very uncertain. Others allege that they have failed in every case in which they have attempted it. Now, in view of this evidence in regard to it, is it not better to allow to remain in contact with the pulp a substance which seems to be perfectly congenial with it, and which produces no irritation, than to place in con-

tact with it, a substance which experience shows is liable to produce the injurious results alluded to?

The following case is the best answer to these questions:

CASE.—Mr. K——, æt. about forty-five. Had occasion to perform a number of operations upon this gentleman's teeth about two years ago. On the left side of the lower jaw the dens sapientiæ alone remained. It had been decayed for a considerable time, and from its appearance I concluded that the pulp must be reached. It had given him no continued pain, however, but was exceedingly tender to pressure, so that it was quite useless for mastication. For several reasons, unnecessary to state here, I was unwilling, except as a last resort, to extirpate the pulp, and determined to make an effort to save it without resorting to this extreme measure. On examining, with an instrument, the cavity, which occupied nearly one-half the diameter of the surface of the crown, I found it extremely tender to the slightest touch, and could remove but a small portion even of the decayed bone, the greater part of which I allowed to remain in the cavity. Indeed, I did scarcely any thing more than to take away the very much softened portion. I then dried out the cavity as well as I could and filled it with tin foil. The tenderness under very slight pressure, however, was so great that I could not use force enough to make any thing like a good filling. For several weeks after this operation was performed, the tooth remained as useless as ever, but it grew, eventually, less and less tender to pressure, and after the lapse of a few months it could be used for mastication without inconvenience. In about a year the tooth again became annoying; slight pain being experienced when certain condiments were taken into the mouth. On examination, I found that in consequence of the imperfect manner in which it had been filled, the caries had gone on at one side and formed a passage to the tender part of the cavity. I now took out the filling and found that the cavity had not increased at all in size; and I was enabled to remove the greater part of the discolored bone with but slight inconvenience to the patient until I came toward that point over one of the anterior elevations of

the pulp. The rest of the cavity I prepared carefully, and again filled with tin foil so firmly, that at present, after the lapse of nearly eighteen months, it has been as useful as if it had never been touched with disease. In a few months I shall remove this tin filling, and fill firmly and finally with gold.

There is one objection to this practice; it may, like the operation of "capping" the pulp, endanger the final preservation of the tooth, if it become necessary to remove the pulp. For if the operation do not succeed perfectly, and the case is neglected, an inflammation of the peridental membrane may ensue, which will lessen the chances of the final preservation of the tooth under treatment. This difficulty may be avoided, as I think I shall be able to show, and the chances of success so greatly preponderate, and the advantages of this method of treatment are so considerable, that, in the face of this objection, I regard it as more than justifiable that this risk should be taken.

In the treatment of teeth in the condition here alluded to, there are many things requiring special attention. Most of these will doubtless suggest themselves to every practitioner of experience who can admit the correctness of the principle I have suggested. It may, however, be useful to some to state in some detail my own general method of treating these cases.

The standard to which we must refer all preservative operations on the teeth, is undoubtedly this: what can we do in each individual case, to preserve the teeth for the longest period of time in the most healthy condition.

If the ground I have taken could be established beyond a doubt, then the matter would be quite easy, for we would not be solicitous, in any case, entirely to remove the decay from any cavity which came under treatment. But as this is a question, it is desirable in all cases to remove every trace of decay, and it becomes important to consider well the circumstances in which this may or may not be done without risk of injury to the pulp. Unless of course, this practice is not approved of, and it is thought better to expose the pulp than to leave in the cavity of decay any quantity, no matter how small, of any thing like decomposed bone.

In examining a cavity of decay we may often at once satisfy ourselves of its proximity to the pulp, by considering the class to which the affected tooth belongs, the situation and extent of the decay, the condition of the cavity and the symptoms observed by the patient. At other times it is extremely difficult, without taking such steps as will render impossible the operation here proposed, to determine whether or not the pulp has been reached by the caries.

When we are satisfied, from examination, that the caries has not nearly reached the pulp, and can be removed without danger, the course is plain.

In examining a cavity of decay when there is any reason to suspect that the pulp has been reached, I generally proceed as follows: I ask the patient if he has experienced pain? If so, of what character? If there has been none of any kind, I take it for granted that the pulp is not yet actually reached by the caries, and proceed to the preparation of the cavity.

If pain has occurred, I inquire whether it was of such character as would justify the belief that it is tooth-ache proceeding from an exposed or inflamed pulp.\* If any considerable pain has occurred and continued for any length of time, the preservation of the affected tooth by the means here indicated, is very doubtful, and until some experience has been had, which will enable the operator to discriminate in these cases, it will be better to proceed at once to the extirpation of the pulp.

If, however, the pain has been inconsiderable, indicating only some slight irritation, caused by the proximity of the caries to the pulp, or from extreme inflammation of the dentine, I proceed to a close examination of the cavity. I first wash out all loose extraneous matter, with the syringe, dry it carefully in the usual way, and examine closely with the eye. I then press firmly into the cavity with a blunt instrument, a piece of cotton or lint. If pain is produced only whilst the pressure is

\* I would here refer to the first of three articles published in the "Dental News Letter," on the treatment of the Dental Pulp, by Dr. J. D. White, of Philadelphia, in which the varieties of tooth-ache which occur are referred to their true causes.

continued, and immediately ceases on its being removed, the indications are favorable, and I go on to the preparation of the cavity.

I first remove the carious bone from every part except that directly at the point where the pulp is most prominent. I then carefully prepare the opening of the cavity, and complete its preparation, by removing as much of the softened bone, directly over the pulp, with light touches of the instrument, as can be done with perfect safety ; if there is the least danger of uncovering the pulp, I do not touch this part at all, but, without any hesitation, leave discolored and decomposed bone at the bottom of the cavity. If it will bear enough pressure, I fill with gold, firmly, and mark the case in my note book, for future examination. If there is much tenderness to pressure, I frequently cover the bottom of the cavity with a piece of gold plate, so as to relieve the most tender point, by distributing the pressure over the whole surface. In using a piece of plate for this purpose, in the upper teeth, it will be found convenient to fix it in place by warming it slightly, and touching it to a piece of gutta percha. It will take up enough, and a very slight quantity is enough to fix it in place.

Sometimes, as in the case above cited, the decay will be found so extensive as to make a temporizing course of treatment necessary. In the statement of that case, I have sufficiently indicated my mode of practice

After a filling in such cases as these is completed, either intended for a temporary purpose, or otherwise, the tooth must be carefully watched for a time. If a decided tooth-ache should occur in a tooth so treated, it is pretty conclusive evidence that the pulp has become inflamed, and its removal will become necessary. When this is decided upon, the sooner it is done the better. If the patient should endure the pain for a few days and it should then cease, the removal of the filling and the pulp is just as imperatively called for in most cases, for the suspension of the pain is a mere delusive calm, and will, inevitably, at some future time, return in the form of a very obstinate inflammation of the peridental membrane.

It sometimes happens, and this certainly forms one of the most serious objections to the practice which I have recommended, that the pulp gradually loses its vitality, without causing any pain which the patient will notice, until peridental inflammation, which occurs sooner or later, sets in. All that can be done to guard against this evil is, to charge your patient to come to you on the occurrence of the very first symptoms of inflammation of this membrane, so that you may take advantage of the most favorable moment for treating it. After such an operation, indeed, it will be well to see your patient as often as possible, for a time, to enable you to watch the result. When the pulp dies, a change of hue of the affected tooth always takes place, and a careful examination will detect this fact long before peridental inflammation occurs. The difference between a tooth in this condition, when the pulp first dies, and one in a perfectly healthy condition is very slight, but can, at least in the teeth near the front of the mouth, be detected in a strong light by their opaque appearance. I think it may be set down as a general rule, that the pulp will be found dead when the peridental membrane is considerably inflamed, and when this occurs, the removal of the filling and pulp in cases of the kind here alluded to is indicated.

At the time of writing this sheet, I have a case in my hands strongly bearing upon this matter. A young lady, for whom I have had occasion to perform a number of operations, has been in my hands for two or three weeks. I supposed I had completed all that was necessary to be done for her, and was making a final careful examination before dismissing her, when my attention was drawn to a very slight difference in color between the right superior lateral incisor and the adjacent teeth. I had only a day or two before filled this tooth on the lingual surface, where it was very slightly decayed. On questioning the patient, I found that several years before, she had suffered violent pain for a few days in this tooth, but that it passed away, and she had suffered no pain since. On examining it again closely, I found that it had lost that life-like semi-transparent hue which marks the living tooth, but it was so slight a shade

darker than the rest of the teeth, that, although I had filled it, it escaped my notice. I removed my filling, cut down to the pulp cavity, between which and the cavity of decay, there was quite a thick plate of bone, and found that not a trace of vitality remained even to the extreme point of the canal of the root. I removed the remains of the decomposed pulp from the root and filled it carefully with gold.

After filling with tin-foil, or any other substance, for a temporary purpose, I allow the filling to remain about a year, sometimes longer, before proceeding to fill finally. I take occasion, however, to make several examinations of the case in the interim, and particularly direct my patient if any thing unusual occurs, if any difference, however slight, between this and the rest of the teeth is observed, to come to me at once.



## CHAPTER IV.

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IN the last number of this series of papers, I considered those cases in which the caries had not yet progressed so far as to deprive the pulp of any part of its bony covering, but had approached so nearly to this part of the tooth as either to exercise an injurious influence upon it, or to render it liable to become exposed in the course of the performance of the ordinary operations for the arrest of this disease. Considering it of great importance to preserve the pulp alive, and in healthy condition, I advised and indicated such a course of treatment as, in my estimation, would enable this object to be accomplished.

I come now to the consideration of those cases in which the pulp is actually laid bare, and the affected tooth, in such condition, that a filling inserted in the ordinary way, without previous preparation or unusual precaution, or even in the manner directed in the last number, alluded to above, would give rise to painful symptoms and injurious consequences.

To avoid circumlocution, I shall say, that in this condition the pulp is exposed: by which term, I mean what, indeed, is generally understood both in and out of the profession, that the pulp is, to some extent, deprived of its bony covering.

The propriety of treating teeth after the pulp may have become exposed, with any view to their permanent preservation, has long been questioned. Doubts have always been entertained of the feasibility of saving the pulp alive after it is once exposed: and it has been repeatedly asserted, that any attempt to save a tooth after the "nerve" had been "destroyed," would be sure eventually to result in injury to the patient. It

was alleged that, when the pulp loses its vitality, the entire tooth is "dead," and that nature, from that time forth, would make unceasing efforts to get rid of it, and that it would ultimately be expelled from the jaw. It will not be necessary to waste time in showing, at any great length, the fallaciousness of this opinion, for a large majority of the most intelligent dental practitioners of the present day, agree that teeth may be preserved for many years after having been deprived of their pulps. It may be well, however, for the benefit of those who are just coming into the profession, to take some notice of these objections: this I shall do in few words.

The teeth, it is well known, derive their supply of blood-vessels, nerves, &c. from two sources, viz. from the investing membrane of the root, and from the pulp occupying the internal cavity. By far the more important of the two is the former; indeed, a highly intelligent member of the profession (Dr. Trenor, of New York,) contended, some years ago, that the teeth are entirely dependent upon the peridental membrane for nourishment, and that the pulp is of no particular value after it has fulfilled its office of forming the tooth. In support of this view, he stated that he had seen teeth from which the pulps had been removed and filled, by Dr. Hudson, which had remained as good and useful as any of the rest of the teeth for ten, fifteen, and twenty years. Whatever may be the amount of truth in the position taken by the gentleman here mentioned, every practicing dentist is aware of this fact, (which alone is sufficient effectually to refute the assertion that teeth, from which the pulp has been removed, are entirely deprived of their vitality,) viz. that fangs, upon which artificial teeth are set, by what is known as the pivoting method, will remain in perfectly healthy condition for many years. I have known instances in which they have remained for thirty years, without giving rise to morbid action of any kind. It is well known, too, that the roots of the molar teeth, the crowns of which have been destroyed by caries, remain for years without producing the slightest irritation until they are, by a well known process, expelled from the jaws, and it will be always found, when they

are extracted, no matter how slight may be their adhesion, that the peridental membrane, at some point, retains perfectly its vitality.

No other evidence is necessary to any one, however slightly he may be acquainted with the laws of physiology and pathology, to convince him that teeth are not entirely deprived of vitality when the pulp is taken away, than the fact just stated, that such teeth or roots do remain in the mouth without causing irritation. For it is well known that foreign substances, with few exceptions, cannot remain embedded in any of the living tissues without causing inflammation in such degree as to insure their speedy expulsion.

I do not propose to give more than this slight passing notice to such objections to the propriety of such treatment of teeth in this condition, because, as I have just stated, few, if any, intelligent practitioners of dental surgery, at this day, deny the practicability and usefulness, in some cases, of the process here alluded to, for the preservation of teeth after the pulp may have become exposed.

At the present time, the only question at issue relates to the best means of treating such cases. Two methods are proposed for this purpose, the objects of which are: 1st, Preserve the pulp uninjured. 2nd, To remove it entirely both from the pulp cavity and roots, and fill the place occupied by it with some substance not capable of being decomposed by the fluids of the mouth.

To effect the preservation of the pulp after it becomes exposed, the only means now relied upon by its advocates is, I believe, so to fill the cavity of decay as to avoid bringing the filling into contact with the pulp. This is accomplished either by placing over the pulp, at the place where it is exposed, a cap of gold plate, or so managing the filling as to leave a vacant space between it and the pulp.

The practice has been warmly advocated, and as strongly condemned. In my own hands, as I have already stated—although I am free to confess that I have practiced it in but few cases—it has not proved so satisfactory as to justify me in

recommending it from my own experience. Professor Harris, of the "Baltimore College of Dental Surgery," who has had large experience in this operation, takes strong ground in its favor; and in a late number of the *Journal*, gives the results of a series of observations, running through a period of five years, which places this operation in a more favorable light than I have ever before seen it presented.

But I do not propose to go into a discussion of the relative merits of these two methods of treating the cases in question. It is not, indeed, necessary to my purpose: for, even if it be granted that the process just alluded to is the better one, a question which I am now disposed to leave each practitioner to decide for himself, its more sanguine advocates do not deny that there are cases of frequent occurrence, in which it is not advisable to attempt it, and that, in these cases, there is no alternative left between the sacrifice of the affected tooth and the extirpation of the pulp.

In some cases at least, then, in the present state of our knowledge, this operation becomes indispensable, and the best methods of performing it should be freely canvassed.

It may be well here to show why it is that when the destruction of the vitality of the pulp cannot be avoided, its entire removal is considered necessary, and what is expected to be accomplished by this and by filling the place occupied by it. This I shall endeavor to do.

The entire removal of the pulp, when this operation is attempted at all, is necessary for two important reasons. 1st.—To prevent inflammation of the peridental membrane, alveolar abscess, and its consequences. 2d.—To prevent the subsequent discoloration of the teeth so treated.

When the integrity of the body of the pulp is once even partially broken up, either as a consequence of diseased action, or in an attempt to destroy its vitality, it is my opinion that it rarely if ever again properly performs its functions. Its circulation no longer goes on normally, the blood which continues to be brought through the canal of the root, and through the healthy to the diseased part is no longer returned to the system,

but escapes in the form of serum, lymph, healthy or unhealthy pus. As long as any portion of the pulp, retaining vitality, remains either in the pulp cavity or the canal of the roots, to invite blood into the interior of the tooth, this must occur. When it is removed and excised at the extreme end of the root, it may easily be conceived that these parts recover their healthy action, and in a little time, the blood formerly brought into the dental cavity is diverted by the anastomosing vessels into some other channel.

It is obvious, that as long as the matter formed in the pulp cavity or roots, finds means of ready exit, no pain or trouble of any kind will occur; but as soon as its egress is obstructed, it will accumulate till the vacant space is filled, and as the blood continues to be forced into the cavity, will give rise to a train of painful symptoms and consequences, with which every dentist is so well acquainted as to render a description of them unnecessary.

It does not follow, however, that in such cases, even if the obstruction is a permanent one, that teeth in this condition, will inevitably be lost. For, if the subject has the fortitude and patience to bear for a time the painful consequences which ensue, relief from pain will finally come in the form of an alveolar abscess, and the forming matter will once more find a way of escape. In time, the remaining portion of the pulp will be entirely deprived of its vitality, the cause of irritation, if so much of the integrity of the periosteum about the apex of the root is not destroyed, so as to leave the bone bare, and consequently a cause of unceasing irritation, will pass away, the abscess may heal up, and the tooth become apparently healthy. But in such cases there is generally unhealthy action about the parts for many years, and a permanent discharge is kept up.

A great deal more could be said here, but as it properly belongs to another branch of my subject, the cause of and treatment of disorders of the peridental membrane, I will now pass it by.

2d. The entire removal of the pulp is necessary to prevent the discoloration of teeth treated in this way, because the

decomposed tissues, and the discharged matter, will gradually pass into the bony substance of the crown, by which this part of the tooth will become, as is well known, much discolored, and eventually, in some cases, quite black. This is seen in a marked degree, in cases where, by a blow, the vessels passing to the pulp are destroyed. As a consequence of the death of the pulp, this discoloration of the teeth is so well known that we are many times asked by patients to whom this operation is proposed, in the case of teeth near the front of the mouth, whether they will not turn black. To accomplish this object, it will readily be seen, however, that the entire removal of the pulp from the minute portions of the canals of the root, is not so necessary as for the object just indicated, for if the pulp cavity and one-third of each root were filled, if no other untoward consequences were to be anticipated, the infiltration of the small remains of the pulp into the dental bone, would be effectually prevented.

The utility of the other part of the process: that of filling with gold, the place formerly occupied by the pulp, is not so clear. It is contended that after the pulp is entirely removed, fluid of some kind escapes from the point at which the vessels have been excised, and that it is important that such fluids should be excluded from the canal in the root and the pulp cavity, because they are liable, eventually, to bring about the destruction of the tooth treated, by being decomposed and passing, by infiltration, through the parieties of the root, and thus reaching the peridental membrane. But even if this do not occur, such fluids, if it be granted that they do escape at this point, and find their way into the root, must effect the discoloration of the tooth by passing into the bony substance of the crown.

It is very easy, indeed, to conceive that a small quantity of fluid may be thrown off from these excised vessels, which may pass into the pulp cavity. If space is left for such fluids to accumulate and be retained until they become putrid and acrid, they must be productive of injurious consequences to the surrounding parts, either by passing through the root, as above

indicated, or filling completely the pulp cavity, and fang, they are thrown back upon the surface from which they have come, producing there all the consequences of the contact of such matters with living tissue. It is supposed that such fluids will again be absorbed, if they are immediately thrown back upon the surface from which they have come, which, it is maintained, will be accomplished by filling the root to the very apex, so as to leave an exceedingly small vacant place only, for the accumulation of such matter.

Such are some of the reasons given for the necessity of the perfect filling of the root in these cases, by those who have most extensively practiced this operation.

But it is by no means satisfactorily determined that any discharge does take place from the excised vessels and nerves, without the root, which are supposed to recover their healthy condition. And I am bound to say that observation has not satisfied me that it is the case. It is certainly safer and better, however, to fill carefully the larger roots of such teeth as are treated in the way indicated. But I cannot discover the utility of this practice in the case of those minute, hair-like canals in the external root of the upper molar teeth, which cannot, indeed be filled unless they are first enlarged; and this is a process which requires so much time and labor, as so much to increase the cost of the operation as to place it out of the reach of most persons.

The utility, and in some cases the necessity, of the operation just indicated is now admitted by the better portion of the profession. But there is still amongst these a difference of opinion as to the best manner in which it should be performed. It is still a question whether it is better to remove the pulp with instruments alone, or first, by some means, to deprive it of vitality. For this purpose it is scarcely necessary to state that arsenic in some form, has for some years been extensively and almost exclusively used. It is well known, too, that this agent will certainly, uniformly, and completely, destroy the vitality of every portion of living tissue with which it is brought into contact, and if in the case of the dental pulp, it is

employed with proper precaution, will effect this object without producing pain of consequence.

It has lately been proposed to apply the actual cautery by means of galvanic electricity. The instrument proposed for the purpose, has already been described in the "Journal." For the destruction of the vitality of the body of the pulp, this instrument could no doubt be readily and effectually applied, but when it is remembered, that a *loop* must be formed of the platinum wire used, it will at once be seen how impossible it would be to pass this into the canal of the root, in those cases in which it will scarcely admit an instrument a great deal larger than a single hair. This instrument, as beautiful and effectual as it seems on first presentation, is, I think I can show to be, of little value for our purpose. It is certainly so if it cannot be applied to the pulp in the contracted canals of the roots, for a better method of destroying the vitality of the body of the pulp, is by the application of arsenious acid; it is better, because it is certain in its effects, painless, and, I think I can show, harmless.

The dental pulp is endowed with a high degree of sensibility; when, from any cause it becomes inflamed, this natural sensibility is exalted to such a degree as to render the slightest touch of any foreign substance, a cause of the most excruciating pain. This has rendered it exceedingly desirable that some means should be used first to destroy its vitality, and thus remove this extreme sensibility before attempting to cut it out. Arsenic, as we have stated above, has been found most effectual for this purpose, and at the present time, is used to the exclusion of every other substance known generally to the profession.

It has been strongly contended, however, that arsenic produces results more or less injurious in every case in which it is used, and it is regarded by some as always advisable to remove the pulp with instruments, regardless of the pain inflicted, rather than to use arsenic for the purpose of destroying the vitality of the pulp. This is the question which now divides the opinions of those who practice this operation.

It is not denied that the immediate effects of arsenic, applied for this purpose, are extremely satisfactory, but it is stated that the final good result of the operation is endangered by its use.

The manner in which this occurs, has never been clearly stated, to my knowledge—certainly not in any publication which has come within my reach. But, from what I can gather from various sources, it seems to be the impression that particles of arsenic are absorbed at once, and carried to the peridental membrane, producing irreparable injury to those important parts; or that after the lapse of some time, they, in some way, reach this membrane, and thus cause their injurious results.

Now, as I have stated, I have seen no account of the manner in which arsenic used for this purpose is supposed to be likely to produce injurious results. It has been stated by practitioners of high standing, it is true, that in their practice, it had not proved satisfactory, but had been more or less injurious. But what is their experience, when unsustained by argument, to me, when it conflicts with my own experience? and what is the value of their opinion in this regard, stated to be based simply upon their own experience, without further rational evidence, to the profession at large, when it comes into conflict with the experience of many others of equally high standing with themselves. It is not at this time sufficient to say, that in any one's opinion, a certain course is not a good course to be pursued. Let us therefore examine this question rationally on its own merits.

It has been vaguely stated, from time to time, as we have already intimated, that arsenic applied for the purpose of destroying the vitality of the pulp, would sooner or later, bring about the destruction of the tooth so treated—1st, by being absorbed and carried through the root, and so attack the peridental membrane. 2d. By passing laterally through the parieties of the roots; and 3d, of remaining after the pulp is removed, and in course of time finding its way to the investing membrane.

These are all the reasons I have ever heard of to account for the alleged injurious results of arsenic applied for this purpose.

Let us examine these statements consecutively, for it is im-

portant that we should come to a right understanding of this matter.

First—Can arsenic be absorbed, and by this means reach the investing membrane through the agency of the pulp?

Arsenic, we are told, by high authority, (See Liebig's *Agricultural Chemistry*, chap. xiv, on Poisons, Contagions, Miasms,) is not absorbed when brought into contact with living tissues. It combines with the surface of the organ to which it may be applied, destroys its vitality, and of course the power of absorption, which is a vital function. Where the quantity of arsenic applied is so small that every atom enters into combination with a corresponding number of atoms of the living tissue, if the organs have vigor enough, it is thrown off with the tissue which has been destroyed by its action. If there is an excess of arsenic, it may reach the vital portion of the tissue below the surface, by imbibition or capillary attraction.

If this authority is of any value—and even if it is not, the known action of arsenious acid upon the living tissues, is sufficient to bring any reasoning mind to a similar conclusion—it must be plain that arsenic cannot reach the investing membrane of the root by absorption.

It may, however, if it be applied in excess, and allowed to remain sufficiently long, gradually penetrate so far by passing through the destroyed portion in the way indicated, to the vital portion, and so on till it has passed through the root.

But, although it must be granted, that injurious effects may occur in this way, it can easily be shown that arsenic, applied in the usual manner for destroying the vitality of the pulp, is not allowed to remain long enough to produce the effects indicated. It is generally allowed to remain twenty-four hours only. That this is not sufficiently long to enable it to make its way through the fang, by way of the canal, is abundantly proved by this fact: a small portion only of the pulp, on the removal of the arsenic applied, will be found deprived of vitality; it is probable that the vitality of the body of the pulp will be destroyed, whilst the portion in the fang will be found to retain all its vitality, and to display an increased degree of sensibility.

Now, this must be regarded as incontestible evidence, that the arsenic applied has not passed through the root, because its invariable effect is to destroy entirely the vitality of any portion of living tissue with which it comes into contact. It may be said, that the fact that the part alluded to, retains its vitality, is no evidence that some of the arsenic has not reached it, but only that it has not had time to effect its destruction; but this objection is shown to have no weight, because these parts retain their sensibility for many days, and even weeks, as all who have practiced this operation must have found.

If the views and facts here presented, be correct, it is clear to me that no injury can reasonably be supposed to follow the use of arsenic in the ordinary way for this purpose, by absorption, and that when allowed to remain the usual time, no bad effects can follow. I should be glad to be shown it, if I am wrong in the position I have taken. I am sincerely in the search of truth, and am not anxious to establish any of my own opinions, unless they are founded upon this basis.

Second—Do the particles of the arsenic applied, pass laterally through the parieties of the fang?

Third—Do particles of arsenic remain after the pulp is removed, and ultimately reach the investing membrane, and thus, after a lapse of time, give rise to injurious consequences?

These queries may be answered together.

The only way in which this is possible, after the pulp is carefully and entirely removed, will be by passing through the bony substance itself by capillary attraction. That this is possible when it is remembered that the dental bone is porous, and the arsenious acid is in a minute state of division, as it is when rubbed up with creasote, which, I believe, is capable of dissolving it, cannot be denied. But that it does not occur, is sufficiently evident from a little careful observation, and a little careful consideration of the phenomena, which would present themselves if this did occur. The arsenious acid is generally applied in the same manner, dissolved in creasote, generally in the same quantity, and allowed to remain the same length of time. Making due allowance for the difference in density of

the teeth of different individuals, we must look for some degree of uniformity in the results of arsenic used in this way. It would take a certain length of time for the arsenic to pass through the root, and we cannot suppose the difference of density usually found to exist in the teeth of different persons, would make any very great difference in this respect. The time required to allow the arsenic to pass by this means through the bone, reasoning from the analogous case of the same substance applied to the bone of a living tooth near the pulp, could not be very long. A month, we should think, would be ample time. Yet, after years have elapsed, we observe no consequence of the kind. And it must be remembered that if arsenic found its way through the root in this way, that its peculiar effect upon the investing membrane would with certainty display itself, and would with certainty result in the destruction of such parts of the investing membrane which it touched. I find it impossible, then, in this view of the case, not to conclude that none of the arsenic after it is applied in the usual way, is left behind after the pulp has been removed and the pulp cavity and canal in the root washed out, or if any should remain, it is so inconsiderable as to do no harm.

I think I have shown that we have no reasonable ground to suppose from the nature of arsenic and the manner in which it affects living tissues, that it can exert any injurious influence when applied for the purpose here indicated.

I am anxious that this point should be established, for, unless we can use arsenic or some agent effectual for the purpose accomplished by it, our usefulness in this way will be extremely limited. The removal of the pulp, unless it is first deprived of vitality, is, in all cases, a painful operation, in most cases excruciatingly so. It is a painful operation to remove the pulp from the incisor and canine teeth, but it can be done with great rapidity, and although the pang of pain produced is, in most cases, exceedingly severe, it is so soon past, that many persons can be induced to bear it. But when the pulp is to be removed from the contracted fangs of the molar teeth, in which it is often exceedingly difficult to find even the openings of the

fangs, the operation is so excruciatingly painful, that I am sure not one patient in fifty, who have passed through my hands, would be willing to submit to it. I have already endeavored to show why it is important that the pulp should be effectually removed.

I am aware that gentlemen have declared that the pain attendant upon the operation is inconsiderable, but this is inconceivable, I must confess, to me, unless it is performed by some method with which I am unacquainted.

I have thus far been endeavoring to show that arsenious acid used in the manner in which it is usually and generally employed in the profession at the present day, cannot reasonably be expected to do the injury which has been attributed to its agency. It must be remembered that many, if not most of those gentlemen who have opposed its use, have been extremely cautious how they have applied it, using a very small quantity (the twentieth part of a grain) and allowing it to remain a very short time, (from twelve to twenty-four hours.) This last point is strongly insisted upon, as also the importance of avoiding a second application to the same tooth.

Now, I am prepared to go still further, and to declare my belief from careful observation of the effects produced by it in my hands, that it may not only be applied more than once, but be allowed to remain much longer than this, not only without injury, but with great advantage. It is true, that I do not use it in the form of arsenious acid, and this may make an important difference. Of this I will say more in the proper place.

Before proceeding farther, I beg leave to offer in proof of these assertions, and the above reasoning, a record of some of the cases which have passed through my hands in the course of the past six years. I have not kept a record of all my cases. Those which I now present have not been selected. In almost every case here cited, the arsenious acid has been applied more than once, in some cases as often as five or six times.

Since January, 1846, the time at which I began to record these cases, I find marked down the treatment of seventy-seven teeth in this way.

Of these, 19 were incisor, or canine teeth.

31 were bicuspides.

20 were first and second molar teeth.

7 were dentes sapientiæ.

Of the incisor and canine teeth, 18 were of the upper, and 1 of the lower jaw.

Of the 31 bicuspid teeth, 22 were of the upper, and 9 of the lower jaw.

Of the 20 first and second molar teeth, 14 were of the upper, and 6 of the lower jaw.

Of the dentes sapientiæ, all were lower teeth.

Of these cases, I have, from time to time, covering several years, seen twenty-six. I have not been obliged to extract one of these. In one only, which has come under my observation, has alveolar abscess occurred, and this by no means an aggravated case. It formed in about two years after the operation was performed. The tooth treated was an inferior dens sapientiæ, and an unfavorable case, because, from a variety of causes, it was impossible to perform the operation thoroughly. Another tooth filled for the same lady at the same time, a second inferior molar, was in a perfectly healthy condition, presenting no trace of inflammation at the time I had an opportunity of examining the other one.

Of these cases, I have seen six which had been treated in this manner, some considerably over two years, and all over eighteen months, these were in a perfectly healthy condition, no trace of peridental inflammation being apparent.

In some of these twenty-six cases, seen several months after the operation, there had been occasional slight attacks of inflammation of the peridental membrane, evinced by more or less tenderness to pressure, but which always passed away without giving rise to serious consequences.

I have not felt obliged, as I have stated, to extract a single tooth I have treated in this way, during the five years I have been in practice in Washington. I have treated more cases than I have recorded, and the patients are where I should be sure to hear from them, if trouble occurred. That not many

of them have passed into the hands of other practitioners, I may safely conclude, because most of them still send their friends to me, when they desire the services of a dentist.

It will be observed from this statement, that I have seen, from time to time, one-third of the cases of this kind which have come under my treatment. Out of these, but one case can be said to have failed, and this was evidently traceable to an imperfect operation. But even this cannot be regarded as a failure, for many such cases of abscess occur, which are completely cured by the removal of the irritating cause, probably in this instance some portions of pulp remaining in the smaller parts of the canals of the roots, and they frequently heal spontaneously.

What I principally desire to establish, by the recorded cases offered here, is that the bad effects attributed to the action of arsenic applied for the purpose of destroying vitality of the pulp, do not in reality follow its use. For if any portion of the arsenic applied were to reach the external membrane, which it could only do by passing laterally through the parietes of the root, for all ingress through the root must be prevented by the filling, it would certainly and surely, and speedily produce effects which would make the extraction of the tooth necessary. The same would be the result if any portion, however small, were allowed to remain in the canal above the filling, its effects would, indeed, be more quickly displayed.

I know that such records of general results as I have presented here, are not very highly valued in the profession: for men, the most honest in their intentions, are so apt to see things in a favorable light when they wish to do so. After theories are formed, we are so apt almost unconsciously to make facts bend so as to establish their truth, and facts stated as having been seen in this light, are justly regarded with many grains of allowance. But the cases I have presented, if they are true, and I affirm that no bias or prejudice could lead me to make, knowingly, a single misstatement or exaggeration, even if they do not convince the sceptical of the permanent utility of the operation (for it may, with truth, be said that

time enough has not yet elapsed to test its full value,) it will at least make good the point for which I am now contending, and will show that the operation advised is productive of results sufficiently desirable to warrant its practice. In the course of the treatment of the cases of which I have here presented a mere meagre outline of general results, I have learned many instructive lessons. I have in many of these cases recorded a great deal that was interesting and useful to me at the time, and which has led me to conclusions which I hope I may be able to state in such a manner that they will be useful to others. I know well, now, that if I could have had the same directions to guide me in the course of my own practice, in this way, I should have been saved much trouble and my patients much pain.

## CHAPTER IV.

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IN the last number I endeavored to show the propriety and utility in some cases, and the necessity in others, of the extirpation of the pulp when it becomes exposed. I also explained the object expected to be accomplished by the performance of this operation, and discussed the question of the relative propriety of using arsenic for the purpose of destroying the vitality of the pulp previous to its removal, and taking it away without preparatory treatment. I endeavored to show that the objections commonly made to the use of arsenic for this purpose were not well founded.

The indications which are to determine the necessity of a resort to this operation, the best manner of using arsenic for the purpose, the symptoms developed by its action, and the manner of removing the pulp, with other relative subjects, will occupy the present number.

I have insisted strongly upon the importance of preserving the pulp alive and in healthy condition, when this can be done, but in many cases it will be found exceedingly difficult to determine whether the entire extirpation of the pulp is absolutely necessary, or whether the means indicated in a former number are applicable; whether the caries has reached so nearly to the pulp as to render useless or injurious any attempts to fill over it.

It is my decided impression, although I have not yet perfectly satisfied myself that it is a fact—that when the pulp is

once fully reached by the caries, that it is generally beyond treatment except by extirpation. I believe that contact with the decomposed bone and the chemical agents which bring about its decomposition, will invariably and inevitably produce inflammation of the pulp; and I am inclined to believe that where the pulp remains in a perfectly healthy condition, covered by softened bone, that this is not decomposed, but as I have already intimated, bone in the first stages of formation; and that in all cases where the pulp is carefully uncovered so as to perform the operation of "capping," as it is technically termed, before pain has occurred, that a perfectly healthy substance is taken away, and that the very questionable alternative is taken of bringing and keeping the pulp in contact with atmospheric air. That under such circumstances, a new protective covering of bone may be secreted by the pulp I cannot deny, as it has been positively affirmed by gentlemen in the profession, of high standing, and of whose skill and truthfulness there cannot be a doubt, but I am obliged to say, that no fact which satisfies me of its truth has ever come within my own observation.

All cases, then, in which no pain of any kind, or other evidences of inflammation has occurred, no matter what may be the extent of the caries, I regard as within the reach of the operation indicated in a former number and alluded to above. I state this as a general rule, for I am aware that many persons lose their teeth by decay, without, according to their own statement, suffering pain; but I doubt whether such teeth did not give rise in the progress of the destruction of the pulp to some painful symptoms of inflammation, although they may have been very slight.

Pain, therefore, in my view of the case, may be regarded as an indication of such a condition of the pulp of a tooth as to call for its removal. But as pain occurring in and about the teeth may come from a variety of causes, it must be understood that I mean pain occurring under certain circumstances, and of a peculiar character.

In order to make this subject clear, it will be necessary to

go briefly into a consideration of the various kinds of painful symptoms of the teeth, and their causes, to distinguish them from that which occurs in consequence of true inflammation of the pulp. This has already been very clearly done by Dr. White, in the series of articles alluded to in the introductory number of these papers, and although what I have to say may not differ materially from what will be found in them, it is necessary in this connection, and must, of course, take some peculiar coloring from my own view of the matter.

I shall notice, amongst the causes which give rise to painful sensations about the teeth,

1st. Inflammation of the dentine.

2nd. Inflammation of the peridental and alveolar membranes.

3rd. Sympathy with other painful teeth.

4th. Neuralgia.

5th. True inflammation of the dental pulp from contact with substances foreign to it.

1st. Pain caused by inflammation of the dentine may occur at any stage of the progress of caries, and frequently does occur when it is very slight. It is rarely intense, and is sometimes characterised by patients as a "grumbling" pain. Sometimes it can scarcely be called pain, a simple consciousness of something wrong, an uneasiness about the part, is all which indicates its presence. In ordinary states of health, pain rarely occurs spontaneously in such cases, but cold—an extraordinarily plethoric state of the system—febrile excitement—pregnancy—inflammation of the pulp of some other tooth on the same side of the mouth, are sufficient to induce it. Contact with any hard, and sometimes with moderately hard, substances, or substances below or above the temperature of the blood, is sufficient at times to cause pain, and an attempt to remove the dentine when it is in this condition, with a cutting instrument, will occasion, to some persons, pain of a peculiarly excruciating character. I have already alluded to this in a former number.

2nd. Inflammation of the membranes of the alveolar sockets. From this cause, very acute and long continued pain, which,

from its character, it is difficult to distinguish from pain caused by a high degree of inflammation of the pulp, may be experienced.

In these cases there is always more or less tenderness to pressure, which, indeed, will always determine whether there is any inflammation of the peridental membrane, or of that which lines the alveolus. The pain may vary in a degree from slight uneasiness about the part to exceedingly acute tooth-ache, as it is commonly termed.

The diagnosis of these cases, however, is not very difficult, for it is generally occasioned by teeth in which the nerves are dead. It may, it is true, and frequently is, complicated with inflammation of the pulp arising from any cause.

It is also occasioned by tartar encroaching upon the fangs and destroying as it accumulates, the gum, alveolar processes, and the membranes of the sockets. Some of the most severe cases I have ever met with owe their origin to this cause.

In these cases the contact of cold or hot substances will sometimes occasion severe pain. Sometimes, too, it may be well to mention, while on this subject, severe pain follows the extraction of teeth in this condition, continuing with great violence for several days after their removal.

3rd. Sympathy with other painful teeth. It is a fact well known to those who have observed the phenomena attendant upon diseased teeth, that pain may be felt in those which are quite distant from the tooth, or teeth, in which it originates. This is so common, that an experienced dentist will never rely entirely upon the patient's indication of the painful tooth when extraction is required. Mere proximity does not account for the fact, as sometimes teeth in the opposite jaw to the one which may be affected will be painful. Sometimes the really diseased tooth will not be at all painful, and will only be detected by the fact that it is found to be carious, and to some extent, affected with peridental inflammation. This kind of pain may occur in a tooth perfectly sound; although I am not so well satisfied that this is so; but it is generally an indication that the tooth in which the pain exhibits itself from sym-

pathy with one which is diseased, is, itself, more or less diseased, and attention ought to be directed to it, after the one which is the original cause of the painful symptoms is attended to.

Pain occurring from this cause varies in intensity; it may be slight, and the whole of the teeth on one side of one of the jaws or face be affected at the same time, or it may be confined to a single tooth, and thus may exhibit all the characteristics of pain arising from genuine inflammation of the pulp.

4th. Neuralgia.—This is another prolific source of painful sensations about the teeth, and this may affect teeth which are perfectly sound, and apparently healthy. This affection, obscure in its pathology, and exceedingly difficult of treatment, is one, to the observation and study of which, every dentist ought to give careful attention.

The character of the pain of neuralgia varies so much that it cannot be described unless all the terms used to describe painful sensations are employed. A general distinction, however, between pain occurring from this and other causes, has been made, which will assist, to some extent, in judging of the presence of neuralgia. “The description of pain, unattended with inflammation, differs from the pain of inflammation, although the former is subject also to varieties in kind, duration, and intensity. Throbbing, lancinating, or pulsatile pain, *i. e.*, pain accompanied with a sense of motion of the fluids in the parts, is the most characteristic distinction of acute inflammation; and an obtuse aching, or heavy pain, belongs to a congested state of the local circulation. Neuralgia is generally attended, more or less, with muscular cramp or spasm, and such pain is either intermitting or periodical.—*Travers on Inflammation*, p. 47.

I am not sure that the condition of the affected teeth materially modifies this affection. As far as my experience goes it is quite as liable to exhibit itself in perfectly sound teeth as in any others. Where there are no diseased teeth in the mouth, and pain occurring, cannot be attributed to any of the causes enumerated above, and about to be stated, it may be suspected

to proceed from this cause, and an effort made to account for it on this ground.

5th. True inflammation or congestion of the dental pulp.— I come now to the consideration of the circumstances under which pain occurring, may be suspected to proceed from this cause.

Pain produced by inflammation of the dental pulp is not so peculiar in its character as to be at once, and in all cases, distinguished from pain arising from any one of the causes just enumerated. In many cases it may so nearly resemble any one of the species here alluded to, that it cannot be distinguished from it. This is what renders diagnosis in the case sometimes difficult.

Sometimes, however, the pain resulting from inflammation of the pulp, together with the extent to which the painful tooth is affected with caries, is of such character that it cannot be mistaken, and no operator of any experience will be deceived. But as the inflammation or congestion giving origin to painful symptoms may subside spontaneously without leaving a trace behind, and the patient forgetting what he had suffered, does not describe accurately the symptoms, and as it can never be ascertained with perfect precision, by examining the cavity of decay, how nearly the caries has approached the vicinity of the pulp, it frequently becomes an exceedingly nice question to determine, whether an attempt may, with any hope of success, be made to preserve the pulp alive, or whether the operation of which I am now treating is indicated. There are some instances, indeed, in which this is actually impossible, and the matter can only be determined by resorting to a test which I shall presently describe.

On examining the teeth of a patient in my hands, if I find any which, from the depth, extent, and situation of the caries, give me reason to believe that the pulp has suffered, or is in danger of suffering, I proceed to ascertain their exact condition.

I first inquire of the patient if he has suffered pain from the tooth, or teeth, in question. If none has occurred, and strong,

hard pressure made upon a pledget of cotton placed in the cavity gives no pain, I proceed as in ordinary cases.

If no pain has occurred previously, and strong pressure produces pain, which, however, immediately passes away, I proceed as already directed in the third number of these papers.

It sometime happens, even before the pulp is in any way injuriously affected, and the practice above is applicable, that pressure made, as directed here, will produce pain which does not immediately subside. In many of these cases, the teeth will be insensible to the effects of external agents, with which they may ordinarily be brought into contact, and as a general rule, they may be distinguished by the fact that no pain of consequence has, up to the time of examination, occurred spontaneously; or if pain may have occurred, it is of such character as could be referred to inflammation of the dentine.

If violent and continued tooth-ache has occurred, although the tooth coming under treatment may be perfectly free from pain at the time, it may be generally regarded as an indication that the pulp is in such condition that it cannot be successfully treated by any other means than its entire removal. But to be certain that such pain as may have occurred did not proceed from inflammation of the dentine affecting the pulp, the cavity must be examined with great care. In the first place, I carefully wash out the cavity with tepid water, used by means of a syringe, having a tube, curved nearly at right angles with the barrel. This will be found a most valuable adjunct in this and other operations on the teeth. In many cases where the bottom of the cavity can be plainly seen, a small opening into the pulp cavity will be discovered. If this is not apparent, I remove carefully, with a small instrument, the softened bone situated immediately over the most prominent point of the pulp. In these cases it will generally be found so soft that a delicate instrument used gently—and all rough and rude manipulations ought to be carefully avoided in these cases—will push through it. If, however, it should be found to possess considerable consistence, it will be advisable to attempt the operation above alluded to, unless pressure produces so much pain as to put it out of the question.

Inflammation of the pulp may be attributed to two causes, one proceeding from actual contact with some substance or agent which is foreign to it—the other from the irritation caused by a highly inflamed state of the dentine. In both species, pain occurs, but one will, in some cases, subside, and leave the pulp in as healthy condition as any other tissue, after the subsidence of inflammation; the other may, indeed, pass away, but the pulp has previously been deprived of the protection with which nature has furnished it, and which it may not be able to restore, and it is probably liable to a return of the inflammatory condition.

When inflammation exists, characterized by violent pain at the time a case comes under treatment, there will be little question about the condition of the tooth, or the steps to be taken.

I find it extremely difficult, without being too diffuse, to give such full directions to the tyro in the profession as will enable him to treat, without embarrassment, the variety of cases of this kind which will come into his hands—experience alone will enable him to do this—and these hints, I am aware, can be valuable only in assisting him at the outset to avoid some serious difficulties. To the practiced operator, these details will probably be tedious and useless.

After having indicated, to some extent, the means by aid of which to ascertain whether the pulp is in such condition as to render its extirpation necessary, I come now to a closer consideration of the process by which this is accomplished. I have already discussed the relative propriety of its removal with or without the use of arsenic for the purpose of first destroying its vitality, and have declared my decided preference for the latter method.

Even with this invaluable agent for the destruction of the vitality of the pulp, great difficulties have been encountered in making it effectual; and there are many points about the best means of applying it, and the symptoms to which it gives rise, of importance to the novice in its use, and well worthy to be examined in detail.

The form in which arsenic is generally used for this purpose,

is that of the arsenious acid, (As Oz,) known also as arsenic, white oxyde of arsenic, white arsenic, ratsbane. A few words in relation to its nature and properties may be useful.

Arsenious acid is sometimes found native, but generally in combination with copper, iron, cobalt, and nickel, as a sulphuret, from which it is obtained by roasting these ores. It is principally obtained for commercial purposes from cobalt, in which it sometimes exist, in the large proportion of fifty or sixty per cent. It is abundantly prepared at Joachimsthal, in Bohemia, from arsenical pyrites, and arsenical cobalt, which are roasted in reverberatory furnaces, and the vapors condensed in a long flue, or series of chambers, the contents of which, submitted to a second sublimation, affords the *white arsenic* of commerce.—(*Brande.*) The commercial arsenic is white, transparent, and glossy when fresh, becoming milky and opaque by exposure; so that the two states are observed on breaking a mass, which is opaque on the exterior. As it is sold in powder in the shops, it is often adulterated, and it is always advisable to purchase it in the lump. If wanted perfectly pure, it may be obtained by pulverizing the commercial article, and digesting it for some hours in aqua ammonia, at a temperature of  $160^{\circ}$  or  $170^{\circ}$ , frequently shaking the vessel; the clear, warm solution is then poured off, and in cooling it, deposits octohedral crystals of the acid, pure and free from ammonia.—(*Berzelius.*) Arsenious acid is soluble in water, in acids, and oils. The opaque is more soluble than that which is transparent. It has been ascertained that 0.96 of the transparent, and 1.25 of the vitreous, dissolved in 100 parts of water at  $60^{\circ}$ ; at  $212^{\circ}$  9.68 of the former, and 11.47 of the latter dissolves, and when these solutions are cooled down to  $60^{\circ}$ , 1.78 of the vitreous, and 2.9 of the opaque are retained.—*Guibourt.*

On other authority, it is stated, that the transparent variety is much more soluble in boiling water than the opaque.—(*U. S. Dispensatory.*) Used internally, arsenious acid acts as an alterative and febrifuge. It is exhibited in doses of a sixteenth to an eighth of a grain. Applied externally it acts as a caustic.

Besides the arsenious acid, arsenic in another form is used; as it is found combined with cobalt in the cobalt ore. Cobalt is generally of a dark, or reddish gray color. It sometimes contains as much as 55 per cent. of arsenic.—(*Ure.*) It is not soluble in water, or oils, at any temperature.

I have used cobalt a great deal for the purpose of destroying the pulp, for some time past; I found that it possessed some advantages over arsenious acid when employed in the usual way; but a new method of using the arsenious acid, which I shall presently describe, gives this agent a decided preference over cobalt in consequence of its more easy solubility, and more rapid action. Indeed, on reflection, upon a suggestion made by Dr. White, I do not see how, theoretically at least, cobalt should be preferred to the arsenious acid; for if the pulp is to be destroyed, the more quickly this is accomplished the better. But for the purpose of removing that excessive sensibility of the dentine, described in a former number, this agent is invaluable; and I cannot refrain from taking this opportunity again to urge a trial of it, for this purpose, upon the profession. I have now been using it for nearly two years with the most satisfactory results.

The preparation of arsenious acid generally used for the purpose in question is, equal parts of arsenious acid and sulphate of morphia, rubbed up in creosote, to the consistence of a thin paste. As creosote is so disagreeable to many persons, it has been proposed to substitute for it some of the essential oils. A writer in the "Journal" has suggested oil of origanum. I have not tried any of these, but think the suggestion a good one.

This compound is used instead of the simple arsenious acid, in order to prevent the pain caused by the destructive action of the acid. It has been suggested by Dr. White that the creosote has no agency in diminishing the pain caused by the action of the arsenic, except in dissolving the arsenic more perfectly, bringing its particles more certainly and rapidly into contact with the pulp, and thus so quickly destroying its vitality as to prevent irritation. The morphine, in the preparation, he

supposes to be the agent which prevents the pain, which would otherwise be produced. I do not, however, agree with him in this view of the case.

About the twentieth, or even thirtieth part of a grain of arsenious acid, it is generally agreed, is sufficient to effect the destruction of the vitality of the body of the pulp. This is applied by touching to the arsenical paste, a small piece of raw cotton or lint, and laying it in the cavity, against the part of the cavity nearest the pulp. If cobalt is used, it will be found simply sufficient to saturate the cotton with creosote and touch one side of it to the powdered ore.

A very nice and important step in the process, is properly to secure in the cavity the preparation employed. As the exposed pulp is often exquisitely sensitive, it will not bear the slightest pressure, and it was at first found quite difficult to confine the preparations in the cavities of some teeth without making so much pressure upon the pulp as to render the process exceedingly painful. Several methods have been devised to escape this difficulty. Dr. Maynard covers the preparation with a lead cap, and then fills the cavity of decay with wax, into which a quantity of cotton is worked. The lead cap, it is obvious, so protects the pulp, that enough pressure can readily be used to make the wax sufficiently firm to remain as long as desired. Dr. White suggests passing a ligature around the tooth where the cavity is on a lateral surface, and when difficulty is experienced in securing the cotton placed over the preparation. In some cases, this method is invaluable. The means I have generally used, and which in the large majority of cases I find perfectly effectual, is to make an alcoholic solution of gum sandarac, and saturate with it a piece of cotton sufficient to fill the cavity over the preparation. When the cavity is deep enough, and sufficiently well shaped to hold a filling of any kind, cotton prepared in this way is very easy to use for the purpose, it will effectually exclude moisture, prevent the escape of a particle of the preparation, and remain any desired length of time. The saliva, on coming into contact

with it, immediately combines with the sandarac, the alcohol evaporates, and a firm filling is quickly produced.

I do not regard the complete exposure of the pulp, by the removal of all the decomposed bone which may cover it, as a necessary preliminary to the application of the arsenic. On the contrary, much pain to the patient is often avoided by applying the preparation without first removing any bone by which the pulp may still be covered. This practice, I am aware, conflicts with what appears to be correct theory in relation to the matter; for it might be supposed, as has been suggested by Dr. White, in the articles before alluded to, that the action of the arsenic upon the pulp would produce irritation and a consequent flow of blood to the part, so that the usual consequences of the inflammation of any tissue in a confined bony cavity would follow, and great pain occur. Experience, however, my experience, at least, shows that this is not the case, and it will often be found, where the patient is suffering violent pain, and the affected pulp is still not fully exposed, that the application of either of the arsenical preparations, as above directed, will, instead of augmenting the pain, give almost immediate relief. In most cases, indeed, this action of the preparations of arsenic, when combined with creosote, seems to give rise to but little, if any, irritation.

Whenever, therefore, I determine upon the performance of this operation, I merely syringe out the cavity of the affected tooth with tepid water, dry it, and immediately, without any farther preparation, except, in some cases, to cut away the softened bone near the opening of the cavity, so that it will more readily retain what is placed in it—make my application. After the lapse of twenty-four hours the pulp may be fully exposed with but little pain.

There is some controversy about the length of time the arsenic should be allowed to remain for the purpose in question, and also with regard to the propriety of a repetition of its application. The common practice is to apply it in the manner above described and to allow it to remain from twelve to forty-eight hours, and there seems to be a great and general reluct-

ance to apply it more than once. It will be found, however—at least such has been my own experience—that the pain attendant upon the removal of the pulp is not avoided, in any great degree, by the use of arsenic in the way just mentioned. When the arsenic is removed, after having remained only the length of time just indicated, the body of the pulp will be found entirely deprived of vitality, and of course sensibility, and can be removed with but little inconvenience to the patient, but farther than this, the effect is rather an exaltation of the sensibility of the portion still remaining in the fang or fangs; and the removal of this part of the pulp is, in almost every case, exceedingly painful. To destroy the vitality of this part it has been proposed to repeat the application of arsenic; but this has been objected to on the ground that bad consequences were likely to result from it by its passage through the foramen to the investing membrane. In a preceding number of these papers I have examined this question. I have had no hesitation in applying the arsenic repeatedly for this purpose, and have never seen any injury result from it. The same has been stated to me by Dr. Maynard to be his own practice and experience. It has been proposed to substitute for the arsenic some caustic more rapid in action and less diffuse in its effects; I have carefully tried for the purpose, caustic potassa, nitrate of silver, chloride of zinc, and other similar agents without satisfactory results.

The difficulty with all these agents, arsenic included, even if no fears of injurious results from its use were entertained, lies in the impossibility, by any methods known to me, of bringing them into contact with the parts of which it is desirable to destroy the vitality after the body of the pulp is removed. Till lately this has been an extremely perplexing point to me, and I will mention briefly the various expedients which have been resorted to in order to overcome the difficulties of the case. Dr. Maynard mentions two methods adopted by him, viz. to apply the preparation by means of a piece of thread, the end of which he dipped into it so as to take up the desired quantity and passed into the fang; and to take up some of the prepara-

tion upon a fine instrument and passing it to the end of the fang withdraw it, leaving a small quantity of the arsenic behind. I have modified these methods by taking a fine instrument, warming the point and touching it to gutta percha so as to take up a very small quantity of the gum. This was touched to the arsenical preparation and thus armed was passed into the fang to the extremity and allowed to remain twenty-four hours. Other expedients of the same nature were tried, and although many of them promised well, did not meet my expectations when applied to practice.

In reflecting upon the matter, it was plain to me that, although considerable inflammation of the portion of the pulp not destroyed by the arsenic, occurred, and even extended to the peridental membrane, that no particles of arsenic reached these parts; for if the inflammation in question were caused by the presence of particles of arsenic, the death of the parts would speedily follow, but as these parts retained their vitality for weeks and months afterward, it was fair to infer that they could not have been reached by any particles of the preparation. But it appeared to be equally plain that if a sufficient quantity of the arsenic were used, the pulp itself would answer as a vehicle to convey it not only to the extreme parts of the fang but, if allowed to remain long enough, to the peridental membrane; for as the surface to which the arsenic is applied in the first instance is destroyed, new portions, combined as it is with so subtle a fluid as creosote would readily pass by capillary attraction through the dead to the living parts. It appeared to me then a great mistake to remove the pulp, as it is deprived of vitality, for this, if my view is correct, is taking away the best means of bringing the arsenic into contact with the part of the pulp most difficult to reach.

Reasoning somewhat in this way, I determined to allow my preparation to remain a longer time, and after some experiments proposed about a week, when cobalt and creosote were used. I found this plan much more effectual than any other which, up to that time, I had tried, and warmly recommended it to the profession. It was, however, with reason, urged against this method

that it was impossible to tell with exactness the extent of the action of the arsenic in any given time, and there was danger of allowing it to remain so long as to pass through the foramen and thus destroy the vitality of the membranes within the alveolus. It was necessary, therefore, in order to be on the safe side, to allow its action to stop short of the foramen, and leave a portion of the still vital pulp to be taken away. For this reason, although a great improvement upon the old method, it was so far defective, and the termination of the operation was still more or less painful.

But this step led me to a method which is free from any of the objections and defects which I found in that just described, answering effectually the desired purpose, and placing in the hands of the operator the means of determining, with exactness, the progress of the action of the arsenic applied, and of stopping it at the desired point. This method removes from the process its most perplexing feature to the operator and the most repulsive to the patient.

I have now discarded the cobalt and again taken the arsenious acid, because it is soluble in the creosote, and because I desire more rapid action. It will be perceived by those who have followed me thus far, that I have arrived at these conclusions since the last number of these papers was written.

I have just said that I am satisfied that if a sufficient quantity of arsenic were used and allowed to remain long enough, it would travel along the pulp and effect its entire destruction. More, probably, would be required for the purpose than is generally used, for as it combines with the pulp, as it destroys its vitality and becomes inert, there must, of course, be a sufficient quantity to act upon the whole. If it were possible to know the exact amount required, in every case, to effect this object, a great deal of trouble would be saved—but this is, of course, in the nature of things, impossible. I therefore apply the arsenious acid in the usual quantity and in the usual manner.

After the lapse of twenty-four hours, knowing that the vitality of the whole of the pulp is not destroyed, and not know-

ing whether the minute quantity of arsenic employed has not exhausted itself, I renew the application. On the next day, I remove it, and pass a very fine instrument, prepared for the purpose, into the fang, till a sensitive point is reached, making a mark upon the instrument to indicate the depth to which it has gone. I apply the arsenic again, and the next day examine with the same instrument again, and so on, till the vitality of the pulp is completely destroyed to the end of the fang. The action of the arsenic is not so rapid as to give any ground for apprehension of injury, and sufficiently so to effect the desired object in about a week. In this manner I have succeeded in destroying effectually the pulp, without observing a trace of inflammation about the tooth.

If the tooth under treatment has several fangs, the instrument used may be passed into each, and as the vitality of the pulp in each fang is ascertained to be destroyed, its connexion with the main body of the pulp may be cut off.

I have had a good deal of experience in this practice of destroying the nerve, and I do not hesitate now, from the trials I have made of the process proposed, to declare that it accomplishes an object which I have not yet been able by any other means to effect—certainty of results.

After the vitality of the pulp is completely destroyed, its removal, in some cases at least, is not very difficult. In the incisor and canine teeth, it is quite easy, but more difficult of course, in the bicuspid and molar teeth. This part of the operation demands some special attention.

The first thing to be considered is, the instruments necessary for the purpose. It is, of course, understood, that in most cases, all which has to be done, is to remove from the fang or fangs of the tooth under treatment, a comparatively soft substance unlike the decayed or decaying bone of the original cavity of decay, and not requiring so high a temper as ordinary excavators. But in regard to instruments intended for this purpose there are several particulars to be observed. They must be small enough to pass into the canal of the fang, to the very extremity—they must have some elasticity, enough

to take the slight curves presented by many fangs coming under treatment, and that formed by the relative position of the fang to the opening from the external cavity—they must also possess sufficient strength and toughness to prevent them from breaking when used for the purpose in question—and must be given such form as will enable them to seize hold of the pulp and draw it out. The best material for these instruments which I have yet found, is fine steel, well annealed. The best steel for the purpose, of which I have any knowledge, is piano wire.

Steel is annealed by being heated away from contact with the oxygen of the atmosphere, and kept from contact with it until it becomes cold. A convenient method of annealing steel wire for the purpose in question, is to cut it into proper lengths, and put it into a piece of gun barrel, in each end of which has been fitted an iron plug to render it air-tight. It should be heated to redness and allowed to remain on the hearth where it is heated till it becomes cold. The more slowly this operation is performed the more uniform and soft will be the steel.

After annealing the wire, cut into the proper lengths for the instruments, it is fitted into suitable sockets. For this purpose I generally use steel wire with a socket drilled in it, into which the wire for the instrument is cemented. But any convenient form which may suggest itself to the operator, will, of course, answer. It will be found convenient to have a considerable number so that there may be at hand, instruments of a variety of sizes, thus saving the necessity of frequently changing them.

When securely fastened into the sockets they may be filed down to the required size. It is advisable for those who have never practiced this operation to prepare teeth of the several classes, and make the instruments of such size that they will readily pass into the smallest fangs. In order to obtain the most desirable form, and to preserve as much body as possible, to the instrument, it has been suggested, (by Dr. White,) that they should be square, except in cases where it is necessary that they should correspond with the form of the fang. After

they are reduced to the desired size, they should be well bur-nished, (a suggestion of Dr. Maynard;) this will give them a slight temper, and increase the little elasticity they have acquired in the process of filing. There should now be cut upon them with a sharp knife, small beards, looking toward the handle of the instrument. Care must be observed, too, that the points of these little instruments should be made sharp, so that they will pass alongside of the pulp in the fang, and not push it upward in the attempt to take it away. The use of these instruments is too obvious to need any elaborate description; they pass readily into the fang and will draw out the pulp as they are withdrawn.

Sometimes the fang will require enlarging, and this may be done with a very simple excavator, contrived by Dr. Maynard. It is formed somewhat like a hoe, but with the cutting edge at a more acute angle with the handle. It is made, of course, of various sizes, to suit any case in hand. When used, it is passed into the fang, and pressed slightly to the side toward which the cutting edge is turned and withdrawn—it cuts as it is withdrawn, and brings away with it the chips it makes. It is important that it should be made at a proper angle, for if it varies from this it will either not cut at all, or merely scrape the bone. If properly made and sharpened it will cut quite rapidly. This little instrument is exceedingly useful, too, for enlarging the opening of the pulp cavity before the vitality of the body of the pulp is completely destroyed; for this purpose it is passed gently into the pulp cavity and in withdrawing it the edges are gradually cut away.

Several little matters are to be noted at this place. It is not always so easy as it may appear to the inexperienced to remove the pulp from the fangs. It is not always sufficient to pass the instrument prepared into the fang to bring out the pulp with it on the first trial. The pulp is often toughened by combining with the arsenic or cobalt, holds firmly and resists repeated attempts to take it away. If any vitality remains, this part of the operation becomes exceedingly perplexing and painful to the patient; but I hope the method which I have suggested

will obviate this difficulty. Not unfrequently the pulp will be found partially ossified. These ossifications of the pulp sometimes present themselves in the form of spiculæ in the fangs; but I have sometimes found the whole body of the pulp completely ossified up to the openings of the fangs. These ossific deposits will be found free, but often it will be necessary very much to enlarge the opening to the pulp cavity to get them out of the way.

If, by accident, the instrument used should break—and this is an accident which careful handling should make very rare—it will sometimes be found difficult, and it may be impossible, to remove. If not jammed in the fang so as to be immovable, it may, in many cases, be withdrawn by rendering a small instrument magnetic, and passing gently up till it comes into contact with the fragment to be removed. The use of a magnetized instrument was suggested some time ago by the late Dr. John Harris, for a similar purpose. Once or twice during my practice I have found it impossible to remove the broken fragment of the instrument from the fang, and was obliged to fill without regard to it. I have observed no unfavorable results in these cases which I could attribute to this cause.

There is another important matter which may be appropriately considered here, although it has a more important bearing upon the perfect filling of the fang after the pulp is removed, viz. the best means of gaining access to the fangs of the teeth under treatment. This, at times, requires the exercise of considerable ingenuity, and unless the proper means are resorted to, in many cases the operation will necessarily be imperfect and ineffective. What I mean, will be more clearly understood, by taking, for example, the case of an inferior molar tooth, decayed to the pulp on the posterior proximate side. It is obvious that it will be difficult to reach the opening of the anterior fang from this cavity, and, indeed, it will also be found quite difficult to work readily at the posterior fang, unless a considerable portion of the tooth toward the anterior proximate surface is cut away. This opens a novel and interesting feature of this operation, and the question now comes,

what is the best method of gaining access to these fangs. Cutting away the crown of the tooth, as in that chosen for illustration, so as to reach the fangs, has two objections: it is a very laborious process, and takes away a large portion of the tooth which would be useful for mastication, and although this portion may be restored by the filling, it also involves a great deal of labor, consumption of material, and necessarily adds to the cost of the operation. A much more easy and feasible plan is to make an opening somewhere through the sound bone, and as there is now a choice of location it will be well to consider and ascertain what part is more convenient for the purpose. In order to make this part of my subject plain, I shall take up for consideration each class of the teeth separately. I feel bound to say here, that I am indebted to Dr. Maynard for suggestions in relation to this matter, which have been of great value to me.

*Incisor Teeth.*—When the pulp is exposed on one of the lateral or proximate surfaces of these teeth, if the cavity is not very large it will be best to make the opening, for operating upon the pulp, on the lingual surface just below the most convex point, particularly in case of the central incisors. Through this opening the necessary instruments may be passed almost vertically into the canal of the fang. It is objectionable to cut down toward the lingual surface, if the cavity of decay is small, because it so far takes away from the strength of the tooth. It will of course be understood that when force is applied in a vertical direction, even with the most delicate instruments, it will be at a great advantage over its application out of this line, and the filling of the fang can doubtless be made much more perfect.

The inferior incisor teeth cannot be treated in this way—it would be more difficult to reach the pulp cavities of these teeth from the lingual than from the proximate surfaces. All that can be done is to cut away the labial wall of the cavity till the openings of the fangs are fully exposed. As these teeth are generally less conspicuous than the superior incisors this treatment is admissible.

*Cuspidati*.—There are two reasons why it will generally be found advisable when it is desirable to reach the pulp to use the cavity of decay when it occurs on the proximate surfaces of these teeth for this purpose, rather than to make a new opening on the lingual surface. In the first place, these teeth are thicker across from the labial to the lingual surface than the incisor teeth, and can, without injury, bear greater loss of substance, and for this reason the pulp cavity is less easily reached from the point indicated above than in the incisor teeth.

*Bicuspidis*.—The manner in which these teeth most commonly decay, renders any particular directions unnecessary. From the cavities of decay it will generally be found easy enough to reach the pulp cavity. If, however, the pulp is exposed from decay on the posterior proximate surface, and the anterior surface is untouched, it may be well to say that the pulp cavity can be most easily reached by cutting down the cavity of decay toward the anterior surface.

*Molar Teeth*.—It is with these teeth that the greatest difficulties are encountered in the treatment of the pulp. The variety of places in which they may be decayed, their position in the mouth, and the number of their fangs, all serve to make a very considerable exercise of ingenuity necessary. I can only hope to afford some help by indicating, in as full detail as seems useful, the general plan resorted to to overcome these difficulties.

The *Superior Molar Teeth*, for some reasons, are more troublesome to treat in this way than those of the lower jaw, unless the caries has fully opened the pulp cavity and exposed the entrance to the fangs. I shall examine these teeth with reference to this object, as they are affected by caries, in most of the situations where it is likely to affect them. *Anterior proximate surface*.—From this point, if the caries is extensive, all the fangs may be reached, by cutting down the pulp cavity toward the centre of the crown. If the caries is slight in extent, an opening made near the gum on the labial surface will make it easy to reach the buccal fangs. The palatine fang in such cases may be reached by cutting down the

cavity of decay toward the point formed by the lingual and anterior proximate surfaces. *Posterior lateral surface.*—Through an opening at this point but little more can be done than to make the first application of the arsenic. I have reached the pulp cavity in such cases by making an opening at the centre of the crown and cutting down to the pulp cavity. This will be found a laborious operation, but I do not see how it can be avoided, unless openings are made both in the lingual and labial surfaces, or a very large opening on the labial surface. *Lingual surface.*—In this case the palatine fang only is accessible; to meet the difficulty, an opening must be made on the labial surface as before directed. *Labial surface.*—From this point as it is more accessible, the palatine fang, if the decay is large, may be reached, at an obtuse angle.

It will, perhaps, be understood that these additional openings into the pulp cavity cannot be attempted until the vitality of at least the body of the pulp is destroyed. This is, of course, done by making the arsenical application through the original carious opening. It will, however, be necessary to gain easy access to the fangs before the entire pulp can be effectually deprived of vitality and removed.

*Inferior Molars.*—These teeth, I think, will generally be found less difficult to treat in this way than those of the upper jaw, with the exception of the trouble encountered with the saliva; there is also a difficulty arising from the form of the fangs, which, it is known, are generally flattened laterally, slightly enlarged both toward the tongue and cheeks, forming, in each fang, two canals with a narrow fissure between them. When these teeth are decayed to the pulp cavity on the crown, it is only necessary to cut down into the cavity and open a free way to the fangs. If it is on the anterior surface it will be sufficient to cut down the roof formed by the bone of the crown, so as to reach the posterior fang. If the caries is in the posterior proximate surface, it will be best to make an opening through the sound bone on the labial surface near the gum, and from that place enter both fangs.

The *dentes sapientiæ* of the lower jaw are not generally more difficult to fill than the first and second molars. If decayed upon the posterior surface it will be best to cut away the crown so as fully to expose the fangs; as these teeth are generally smaller than the other molar teeth this will not be found so laborious, indeed I have usually found when the pulp is exposed from caries at this point, that so much of the bone is decomposed as to allow of easy access to the pulp cavity. When the caries affects the crown no difficulty presents itself. The upper wisdom teeth are more difficult generally to treat than the lower ones, particularly those of the left side, as they are not so easy of access.

I find difficulty in describing minutely operations like these, in consequence of the want of a dental nomenclature. Until every important part of each tooth receives its appropriate name this will continue to be difficult. Good service would be done to the profession by the careful preparation of such a work.

There is a point to be considered here of considerable importance, it is this: how is it to be ascertained with certainty that the pulp is entirely destroyed? At first sight this may appear quite an unimportant inquiry, for it will be supposed that as pain is an indication of vitality, when no pain is caused by the use of instruments for the removal of the pulp, it alone will be sufficient assurance that there is no vitality left. But the difficulty is in this: the canal passing from the pulp to the alveolar cavity does not always terminate abruptly near the extremity of the fang, leaving a mere capillary foramen through the fang; there is often a gradual and regular narrowing of this canal till it reaches the alveolus, and not unfrequently the foramen is sufficiently large to permit the passage through it of the delicate instruments used in this operation. This will be shown by passing such instruments through the pulp cavity and fangs of extracted teeth; it will be found in doing this that the finer instruments will readily pass through many of them, even when the foramen is not very perceptible to the naked eye.

This, it will be perceived, is a nice point—it is certainly desirable, at least, if not necessary, as I have endeavored to show, to remove entirely the pulp from the canal ; but how to accomplish this, in all cases, without running risk of wounding or otherwise injuring the parts exterior to the fangs, and setting up inflammation here which it will be difficult to subdue, is a question well worthy of attentive consideration. In many of the teeth the canal terminates somewhat abruptly, near the extremity of the fang, and the instrument used will be stopped at this point. Sometimes the difference between the diameter of the canal at this place and that of the foramen is so slight that the instrument used, although stopped at first, may be passed through the foramen if a little force is employed. In these cases the obstruction to the passage of the instrument indicates the point at which the canal terminates. When the pulp has been removed up to this point, even if some sensibility still remains, it is not necessary to go farther, and to this place the gold is to be carried in filling. It will, of course, be understood that the depth to which the instrument used has passed into the fang, must give assurance that the obstruction is near the extremity.

But it will often be found exceedingly difficult to determine with certainty whether a sensitive point touched by the instrument is a portion of the pulp still remaining in the fang or the part exterior to this. I am aware now that, sometimes, in the earlier part of my practice, I have inflicted severe and unnecessary pain in repeated attempts to remove what I supposed to be some remaining portion of the pulp, when I was afterwards satisfied, that at every attempt thus made, my instrument passed entirely through the fang. This is more to be apprehended in the treatment of teeth in which the vitality of the pulp has been for sometime destroyed ; and particularly so if they have been the seat of alveolar abscess. In such cases the canal of the fang and foramen are very often so much enlarged by absorption, as to admit the passage of quite a large sized instrument. In filling these fangs, Dr. Maynard tells me he is in the habit of measuring the length of the canal by using a fine in-

strument with the point bent at a right angle ; this he passes up the root till it snaps over one edge of the foramen at the extremity of the fang, he then marks on his instrument the depth to which it has gone, and with another suitable instrument carries up the gold exactly to the end of the fang.

In cases where the pulp is not dead, and where there is no enlargement of the foramen, and there is but slight difference between its diameter and that of the canal, it is extremely difficult to know the proper point at which to stop, and the only means of which I know anything, and by which I am guided myself is merely an approximation. I judge from the depth my instrument has passed into the fang of its length, by comparing it with the average length of the fangs of teeth of the same class. It will be well for young practitioners who have not in their minds some adequate idea of the average length of the fangs of the teeth, to keep by them one or more of each class, and compare the length of these fangs with those under treatment. Although this is but an approximation to the desired knowledge, still it furnishes the means of operating with much more certainty than could otherwise be done, for although there is a difference between the length of the fangs of the teeth of the same class of different individuals, this difference is not so considerable, generally, as to make this method of ascertaining their length, entirely unavailable. And even if, occasionally, the length of the fang under treatment should be somewhat longer than it is supposed to be, it will be better to leave a minute portion of the pulp remaining in the extremity of the fang, than to run the risk of wounding the parts exterior to it.

During the process of removing the pulp, or after it is completed, some peridental inflammation is very likely to occur. I have found it much less apt to present itself since using the arsenious preparation in the manner I have described ; and I am inclined to believe, from what I have observed, that a greater amount of peridental inflammation is likely to occur from rough attempts to remove the pulp without regard to the pain inflicted than from the effects of the arsenious acid. I have always, indeed, observed, that in those cases where most pain attended

the removal of the pulp, most peridental inflammation followed. This inflammation of the membranes of the socket, for doubtless the living membrane of the alveolus from its contiguity is involved in the trouble, is indicated by tenderness to pressure, and this may vary in degree from slight inconvenience in mastication to severe pain from simple contact with the teeth of the opposite jaw, and even when no such cause as this gives rise to it, to severe and continued pain. Generally when the removal of the pulp is completed some slight inflammation will be present, and it will always be found advisable to wait till this subsides before proceeding with the operation. In most cases the inflammation which occurs will pass away spontaneously, but it may require treatment. It is always best to attend to it without delay, for although in the beginning simple measures will generally effectually arrest it, after it reaches a certain point it will in spite of all treatment run on to suppuration. It will generally be found that chloroform applied along the course of the fang on a small piece of cotton saturated with it, acting as a derivative and probably as a sedative, will effect all that is desired; but if this will not answer, the application of leeches to the part will generally have the desired effect. In using the chloroform, it is necessary to caution the patient not to use it too freely.

In one case in my hands, a lady of delicate habit declared that she was rendered insensible and quite sick afterward by the use of a very small quantity in the manner directed. I could scarcely credit the statement at the time—concluding that the quantity used was much greater than the lady was aware of; but Dr. White has since informed me that he observed in his office, if I am not mistaken, a similar result from a very small quantity of the chloroform. I have made frequent use of it, however, many times with very happy results, and never in any other case met with such consequences.

Sometimes this inflammation of the membranes will continue for a considerable time, and it is best, except when the case is urgent, to wait, using, in the mean time, all appropriate remedies till this subsides, before filling the fang. I do not know

that a disregard of this injunction would absolutely prevent the success of the operation, but it is certain that increased irritation, caused by the force necessarily used in filling would have a tendency to augment the inflammation of the parts, when they were already in an irritated and irritable condition.

But there is another reason why some interval should elapse after the pulp is removed before the fang is filled. Especially is this the case if the removal of the pulp has been rapidly accomplished. A quantity of blood has been regularly brought to the pulp, and when this part of the tooth is in healthy condition has been regularly returned to the system. The vessels bringing the blood into the fang are cut off, and there is an excess of blood which must be diverted to some other use, which is done by the adaptation of the surrounding vessels. Before this is perfectly accomplished, and before the excised vessels are perfectly healed, there will be a greater or less exudation of coagulable lymph, which, if not allowed to escape freely, must react upon the parts from which it has been thrown off, and thus cause trouble.

Nothing now remains to be done, after allowing sufficient time to elapse, with the assistance of proper remedies to get rid of any inflammation occurring about the parts, but to complete the operation by filling the fangs and the cavity or cavities in the crown of the tooth under treatment. This is a nice and delicate part of the process, often requiring the exercise of considerable ingenuity, and always demanding steady and patient manipulation on the part of the operator. This will form the subject of the next and concluding number of these papers.



## CHAPTER VI.

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WE come now to the consideration of the last step in the operation which has so long engaged our attention. I have given an account in as full detail as I thought consistent with justice to the subject, without being too diffuse, what I conceived to be the best means of accomplishing the entire removal of the pulp. It now remains to describe that part of the operation deemed essential to its completion, viz. filling the fang or fangs. This is a comparatively simple part of the whole process, but there are points about it to which some attention may be given with advantage to those who have not had experience in the practice of this operation.

The instruments for filling the fangs, though exceedingly simple in form, require to be made with care. Piano wire is more suitable for this purpose than steel of any other kind or in any other form of which I am aware, and steel is decidedly preferable to any other metal. These instruments do not differ in form from those already described, for the removal of the pulp, except that no barbs are cut upon them, but on the contrary they are made perfectly smooth by burnishing and giving them a spring temper. Except when the canal of the fang, to be filled, is flattened, they should be made round so as to obtain the greatest strength with the least bulk. A number of them should be prepared, and graduated from the smallest diameter of the fang to be filled to the largest size required by the canal at its largest diameter. Tempering such small instruments is, I am

aware, a nice operation, but it renders them so much more available for this purpose, that no pains ought to be spared to accomplish the object.

The best material for filling the fangs is, undoubtedly, gold; it is better suited, in every respect, for this purpose than any other material with which I am acquainted. I see, however, no objection to the use of tin foil for this purpose—it cannot be consolidated so perfectly as gold, but it can be made sufficiently compact to answer the purpose. But gold, as I have just said, is preferable to any other material for the purpose; it can be used more conveniently and can be rendered more compact with slighter compression.

The facility with which gold may be employed for filling the fangs depends upon the form and manner in which it is used. No. 30, is undoubtedly best adapted for this purpose. Whatever may be thought of this gold, (which I introduced to the profession, and which I have used for nearly two years, and which I still use, almost exclusively, with increasing satisfaction,) for ordinary operations, for filling the fangs, it will be acknowledged upon trial, I am sure, invaluable. For this purpose, indeed, Dr. Maynard, to whom I have had occasion so often to allude in these papers, has used gold of this kind for a number of years.

By Dr. Maynard it is cut into a narrow strip, one end of which is carried to the extremity of the canal of the fang with a suitable instrument, which is withdrawn, leaving the gold in place; a fold of the gold near the extremity is taken by the instruments, are carried up to the end, and so, fold after fold is condensed against the first until the fang is filled.

I will describe somewhat minutely my own method of procedure, which I find after trial of other suggested methods, enables me more conveniently and perfectly to accomplish the desired object.

I first cut the gold from a narrow strip into small oblong squares, about two lines in length, and one in width, which I lay in a convenient place for use. I then set in order the instruments I intend to use for the purpose, and take care to

provide several of the smallest size. I then wash out the pulp cavity and fangs with the sponge, and pass the smaller instruments into the fangs to be filled to be sure that they pass readily to the point to which I wish the gold to be carried. The cavity and canal of the fang are then to be carefully dried, which may be done by twisting a small piece of cotton around one of the barbed instruments used for removing the pulp, and passing it repeatedly into the fang. It will be necessary to change the cotton several times, or have several instruments prepared in the same way, as the small quantity which can be used soon becomes saturated.

There are two methods of placing these small pieces of gold in a position where they can be carried conveniently into the fangs—I hope these minute details will not be considered trifling and unnecessary, to many I am sure they will not be so thought, if I judge from my own experience—one is to take up the gold with a pair of spring forceps and place it in the cavity of decay near the opening of the fang, from which place it is carried into and up the fang with suitable instruments—the other is to place the gold on a piece of wood and take it up by sticking the instrument through it, which after some practice will be found a very convenient way of getting over a vexatious little difficulty.

The canal of every fang is a lengthened cone—in some parts it is a simple tube, but from the opening from the pulp cavity to the foramen at the extremity of the fang it is always more or less conical. In filling the fang it is always advisable, in using the small pieces of gold which I have recommended, to carry them into the canal of the fang with an instrument but slightly smaller than the opening from the pulp cavity. As soon as it has passed the opening of the canal as far as the instruments used for introducing it into the canal will go, a smaller instrument is taken with which the gold is forced up somewhat farther until it is again stopped by the narrowing diameter of the canal, and so on till the instrument which was previously ascertained to be sufficiently small to pass to the extreme end of the fang, can be used and the piece of foil carried up to its place. After this

piece is as well condensed as it can be, another similar piece is to be taken, introduced in the same manner and gradually carried up to its place. The length of the pieces of gold foil may be increased with every piece used, and when the diameter of the canal is large enough, as it is filled toward the opening to permit the use of strong instruments and considerable force, strips of the same kind of gold may be employed with advantage.

I make use of gold foil in the manner described in the more contracted parts of the fangs, for this reason: the canal is liable to become choked with the gold, if too much is used at once before it reaches the desired point, and when this occurs, it is impossible, with the necessarily delicate instruments employed, to force it further up or to remove it. The advantages of first using stouter instruments than will reach the extreme point of the fang, and as the gold is carried up taking the finer and finest instruments, a little reflection must make obvious. The smaller instruments would pass entirely through the piece of gold in every attempt to force it into the fang at the place where it is of much larger diameter than the instruments, but as the canal of the fang contracts, the gold is drawn together so as to present a body offering greater resistance, and the finer instruments will then have the same relation to the diameter of the canal, as the larger one when it was larger.

This is my general plan of procedure. It is apparent, that success in this part of this delicate operation requires time, perseverance and careful, patient manipulation. All this, however, is required, daily, in the ordinary faithful practice of our profession, and the man who is afraid to encounter obstacles, and patiently labor to overcome them, will never reach any desirable eminence in this or any other profession in which he may engage. If, however, he is willing to devote himself, in the right spirit, to such labor as this in which I am endeavoring to assist him with my own experience, he will obtain results which will fully reward him for his pains.

The fangs most easily filled are those of the superior incisor and canine teeth. If the directions above given are put into practice, the most inexperienced operator will be enabled to fill

these teeth very perfectly. The palatine fang of the superior molars are generally cylindrical, and when the external opening is favorable, is not difficult to fill. This is also the case with the posterior fang of the lower molars. Since the publication of the last number of these papers, my attention has been called to an error which it is proper in this place to correct. I stated that generally the fangs of the lower molar teeth were flattened, so as to form in each two canals, one presenting toward the tongue, and one toward the cheek. This is the case with the anterior fang; but generally the posterior fang has but one canal in the centre, sometimes cylindrical, sometimes more or less flattened, and sometimes formed like the canals of the anterior fang.

After filling the fang or fangs of any particular tooth under treatment, I always consider it advisable to allow a few days to elapse before filling the pulp cavity and cavity of decay. The irritation caused by the force necessary to be exercised for this purpose is always liable to produce a slight degree of inflammation of the peridental membrane, as it is at this time predisposed to inflammation, and time should be allowed for any inflammatory action to subside. If this inflammatory action should exhibit itself in tenderness to pressure upon the tooth, it will always be advisable to wait till this passes away, and when necessary, by the use of counter irritation along the course of the canal to assist in its dissipation.

Up to the present moment, we have been engaged in this consideration of the treatment of teeth in which the pulp still retained its vitality, and which, as a part of the process it was necessary to remove. In the treatment of such cases, I have met with so much success in my practice by pursuing the method which I have described, that I never anticipate trouble or inconvenience as a consequence. Slight inflammation of the peridental membrane, being all the trouble which is likely to occur; and this, with the least attention, can in every case be subdued with little trouble. In most cases no treatment at all is necessary.

But another class of cases frequently come into our hands

which require particular notice; those in which the pulp is already deprived of vitality, or entirely decomposed. With teeth in this condition, which at first sight would seem to be easy to treat, trouble frequently follows the operation of filling. Why this should occur more frequently when the pulp is dead than when it is obliged to be destroyed whilst in full vitality, is a question well worthy of attention.

Teeth in which the pulps are dead may be divided into five classes:

I. Those which are perfectly healthy.

II. Those which are in such condition that even slight causes of irritation will give rise to peridental inflammation.

III. Those of which the peridental membrane is already in an inflamed condition.

IV. Those which are the cause of alveolar abscess discharging externally.

V. Those in which the matter formed is discharged through the canal of the fang.

I. Teeth will not unfrequently be met with, of which the pulps are devoid of vitality, and in some cases entirely wasted away, and such teeth may be found in perfectly healthy condition. They may be considered in four classes:

1st. Such as are sound or only slightly decayed.

2nd. Such as may have been filled when but slightly carious, or, at least, before the caries has reached the pulp.

3d. Such as may have been filled upon the exposed pulp.

4th. Such as have decayed to the pulp, which has been destroyed by the influence of foreign substances.

1st. The vitality of the pulp is frequently destroyed by a blow upon a tooth, which may either break off its connection with the jaw, or so injure the chord passing from the fang as to cause a high grade of inflammation, which, passing down to the pulp may occasion its death and disorganization. Very commonly a very high degree of peridental inflammation also occurs proceeding to alveolar abscess, but I have a number of times met with teeth deprived of vitality by this cause, which were in healthy condition; as far, at least, as their connection with

the general system was concerned. In some of these cases no trace of previously existing alveolar abscess could be described, nor could it be discovered from the account of the patient that so high a degree of inflammation at any time existed as to have occasioned severe pain. But, even where alveolar abscess has occurred, the parts in time frequently perfectly recover their healthy condition. Teeth in this condition, after the lapse of years, invariably, so far as my observation goes, become more or less discolored, and very frequently the only evidence, besides this discoloration, that there is anything wrong about them, is the wasting away of the gums and edges of the alveolar process. Wherever they occasion any disfiguration they should be treated by making an opening at a convenient point into the pulp cavity, and removing the remains of the pulp, and as much of the discolored bone toward the anterior surface, as can be taken away without risk of making the tooth too frail to bear filling. As it is the dentine and not the enamel which is discolored, the gold underneath will give it a slightly yellowish, but much lighter hue. I have treated such cases in this way with great satisfaction, and have frequently left them with a difference of shade so slight as scarcely to be perceptible to an ordinary observer. It has been proposed in such cases, (by Dr. J. H. Foster, I believe,) to place a piece of white paper just underneath the enamel and to fill up against it; this is certainly an elegant operation, and I see no reason, if care is taken to keep the paper perfectly dry, why it should not succeed.

But teeth will sometimes be found dead, as they are called, and the loss of vitality of the pulp cannot be accounted for in the way above mentioned. I mean, of course, before the pulp has been reached by decay. They may, in this case, be either slightly decayed or perfectly sound. It is an undoubted fact, that the dental pulp is sometimes, though rarely, deprived of vitality by causes of which it is difficult to give a satisfactory account. Further data are necessary to clear views upon this point. Whether there is a spontaneous absorption of the substance of the pulp without sufficient inflammation to occasion pain, which can be recollected by the patient, is a question which

I cannot now determine. It is certain that no trace of pulp, except a small quantity of dry substance, can, in some of these cases, be discovered either in the pulp cavity or canal of the fang, and on inquiring of the patient it will be found in some cases that no painful sensations of any kind have been experienced about such teeth. Whether this information is to be relied upon I cannot now determine. It is certainly possible that in some disordered inflammatory condition of the general system, the vitality of a certain tooth predisposed to inflammation, may be destroyed without attracting the attention of the patient at the time, but it is questionable whether in a state of ordinary health this is likely to occur. In many cases, although no severe pain has occurred, I have reason to believe that some uneasy sensations are experienced from time to time, occasionally amounting to pain.\* I have never known any difficulty to follow the operation of filling the fangs of such teeth.

2nd. Such teeth as may have been filled when but slightly carious, or at least before the caries has reached the pulp.

The death of the pulp, in such cases, may be attributed to several causes : to pressure upon a thin plate of bone separating the pulp cavity from the cavity of decay ; to impressions conveyed to the pulp already in an irritable condition, through the medium of a metallic filling, by substances much below or above temperature of the blood taken into the mouth ; or to hard pressure upon highly inflamed dentine in the vicinity of the pulp, as shown in case III. Generally in these cases severe pain follows the operation of filling, and the inflammation of the pulp occurring, terminates in alveolar abscess. Sometimes, however, inflammation terminates in resolution, and after a time the parts recover their healthy tone. Sometimes after a lapse of time an alveolar abscess will heal spontaneously and the

\* In a late conversation with Prof. Harris, I found that his attention was drawn to this fact some years ago ; that he has made careful observations with reference to it, during his long practice, and will give the results of his experience in a forthcoming edition of his "Principles and Practice of Dental Surgery," which is now in press. Dr. Maynard, too, mentions some interesting cases of this kind which have passed through his hands.

parts will be found in healthy condition. In these cases the indications are the same as in those just described. The probabilities of a successful result are the same.

3d. Such teeth as may have been filled upon the exposed pulp.

It is to be hoped that such cases as these will not be so frequently encountered in the future as in the past. Practitioners of a different stamp from those which have heretofore infested it in great numbers, are coming into the profession now; they will be too well instructed to do anything like this ignorantly, and, I trust, if deterred by no higher motive, will see too clearly the policy of honest practice to do such a thing with their eyes open. If the pulp is exposed at the slightest point, and the cavity of decay so filled as to allow the filling to come in contact with it, the death of the pulp will be an inevitable consequence. But, like the class above indicated, although the peridental membrane will not escape inflammation, it may, and sometimes does, recover healthy action, and the teeth may be treated with good hope of success.

4. When the pulp becomes exposed by the action of ordinary decay to contact with foreign agents, and the pulp cavity is allowed to remain open, there is more apt to be continued irritation and inflammation. This may continue to be the case after the pulp is entirely dead—it will almost certainly be so if the opening of the canal at the alveolar extremity of the fang is not very small. This will be occasioned by particles of food or other substances being forced through the fang so as to come in contact with the peridental membrane. But, in many cases, such teeth will be found in healthy condition, and with ordinary precaution may be filled, with every prospect of their preservation.

II. Notwithstanding the division I have made of these cases, all the teeth in the condition just described must be regarded as liable to inflammation from slight causes; the force used in filling, as I have already intimated, will be often sufficient to produce inflammation of a high grade. But such as already give evidence of peridental inflammation, however slight, as will

be evinced by their looseness and tenderness to pressure, are particularly liable to subsequent severe inflammation.

This sub-inflammatory condition, if it may be so designated, is not always an indication, however, that this operation will be followed by unpleasant consequences, for the irritation in many cases, is kept up by the presence of putrid and acrid matter in the pulp cavity and fangs, occasioned either by the decomposition of the pulp, or after this has taken place, by the discharge of fluid of some kind through the alveolar foramen of the fang into the internal cavity, or the decomposition of particles of food. Hence, it will often be found that this operation instead of increasing the inflammatory action will completely cure it. A common cause of irritation, as already intimated, is the forcing of food and other foreign substances into and through the fang if the cavity of decay remain open, and the removal of the cause of irritation in such case will almost invariably effect a cure. Of this fact the following case is a fine illustration :

Mr. B., *Æt.* 47—May, 1851.—The two central incisors had been dead, as it was said by the patient, for more than thirty years, the cavities of decay, now quite large, had been filled, but the fillings had come out. It was not thought advisable by his dentist to fill them again, but as he was exceedingly reluctant to lose them, as they were strong, useful teeth, he determined to make another effort to save them. On consulting me, I agreed to attempt to operate for him in the case. There was at the time considerable inflammation present, and the gentleman informed me that they were somewhat annoying to him a great part of the time on account of their tenderness to pressure. From this cause it was not agreeable to use them in eating, and he involuntary avoided using them. I very carefully, by repeated use of the syringe, washed out the fangs and filled them in the usual manner. There was no increase of inflammation after the operation—for the probable occurrence of which I was careful to prepare him—on the contrary all the inflammatory symptoms passed away, and on seeing him after the lapse of a year he informed me that in biting hard substances he was unable

to perceive any difference between these and any of the rest of his teeth. For the wife of the same gentleman I filled two bi-cuspids, in very nearly the same condition, with the same result. She assured me that until the teeth had been filled they had been uncomfortable to her for a long time.

In these cases where there is every reason to anticipate more or less unpleasant results, it is always best to proceed cautiously, doing as little at a sitting as can be well done, and then to take every precaution against the occurrence of inflammation, where there is evidently very great predisposition to inflammatory action. I generally at the first sitting simply wash out the fangs and remove any extraneous matter which may be in them. I then close up the external cavity with cotton saturated with the solution of sandarach, and direct the patient to call in two or three days. If any inflammation follows this part of the operation, I wait till it subsides, and make use of such means as seem to be indicated to subdue it; when this is accomplished, or, if at the time appointed no inflammation is present, I proceed to fill the fangs, and then dismiss the patient. When all traces of a periodontal inflammation disappears, I complete the filling. These may seem to some persons unnecessary precautions, but I am satisfied that many cases have occurred in my own practice in which valuable teeth has been saved by this procedure, or, at least, a great deal of suffering on the part of the patient prevented.

#### IV. Teeth in which alveolar abscess is present.

It was for sometime a question with me whether such teeth could be treated with a reasonable prospect of success; it is no longer a question, and I do not hesitate to fill them. There are many considerations of importance involved in the pathology of alveolar abscess, which it was my intention to discuss at length in this place, but I must defer it for the present, and simply be satisfied with a few words in relation to the practice to be pursued in such cases.

There is evidently not the same necessity for caution in these cases as those above described; any increase of inflammation here is rarely attended with painful consequences, and it is, of

course, always well, when it can be done with safety, to go straight on to the end as speedily as possible.

Very frequently an abscess will spontaneously pass away after the fangs are cleared of irritating matter, and carefully filled. If it should not, it must be lanced deeply, and a piece of cotton or lint placed in the incision, and allowed to remain till it is thrown out by healthy granulations at the bottom, or removed when healthy pus has been discharged freely for a time.

IV. When a discharge of pus or other matter through the canal of the fang is suspected, it will be necessary, in the first place, to ascertain whether it comes from a sac, exterior to the fang, or from some remains of the pulp still in the canal.

It sometimes happens that an abscess will discharge for years through the canal of the fang without causing much, if any, inconvenience to the patient, if the external cavity of decay is open, except when its free egress is obstructed, and then severe pain follows.

In such cases, the attempt ought to be made to put an end to this diseased condition of the parts, and it will generally be successful. Let the fang be filled without any other precaution than to avoid pushing the instruments and gold entirely through the foramen, which, in most of these cases, from the long continued action of corrosive matter, will be found enlarged. Dr. Maynard's very ingenious method of managing such cases I have already described. Whether this is adopted or not, some means must be employed to ascertain, as nearly as possible, the length of the fang, to the end of which the gold should be carried.

When the fang is filled in such a case, the usual outlet of the matter formed is closed up, and it must of course escape somewhere. If let alone it will find its way through the wall of the socket—generally through the exterior wall—but great pain will attend this process. To prevent this an opening must be made near the extremity of the fang, through the external alveolar wall. Before filling the fang, an instrument, giving some indication of its length, should be passed into it and marked: when the operation of filling is completed, this should be used as a means of ascertaining the proper place to perforate

the alveolus. This opening for the escape of the pus should be formed at once, as soon as the rest of the operation is completed, for nothing is to be gained by delay; on the contrary, severe inflammation, and great pain will occur. A small sharp drill is sufficient for the purpose. The abscess should then be treated as just described. After all this, it may in some cases be necessary to remove the tooth, and in attempting such an operation the usefulness of the affected tooth is to be considered.

There are cases where the preservation of a single tooth is of so much importance to a patient that it is more than justifiable to attempt an operation which promises very little; there are others upon which it would be useless to waste an ordinary operation. This, of course, is a question to be determined by every operator for himself.

A very curious case occurred in my practice a few years since, which may be mentioned in this connexion. The right superior lateral incisor was filled, but as it was evidently dead and discolored, I advised the removal of the filling for the purpose of enabling me to take away as much of the discolored bone as possible, and also to prevent its further discoloration. On removing the filling I found that the caries had not penetrated to the pulp cavity, which I opened. I then passed a probe to the extremity of the canal; there was no trace of decomposed pulp or fetid matter—no pain was produced. Observed in a moment that the pulp cavity and cavity of decay were filled with what appeared to be saliva. This I carefully dried out, and placed a napkin around the edges of the cavity of decay, over which I supposed the saliva had flowed. In an instant more the cavity was again filled with the same fluid, and I soon discovered that it came from the canal in the fang. I watched it for some time, and after wiping out the fang carefully, I could discover in a very short time the canal and pulp cavity fill with a limpid fluid, which flowed in considerable quantity, coming with distinct impulses, synchronous with the pulsations of the coronary artery of the upper lip, which I could distinctly feel beating under my finger. I filled this fang in the manner just described; an opening already existed through the external

wall of the alveolus ; when I next saw the patient, which was in the course of a few days, an abscess filled with pus had formed in the place where one had before been. I lanced the abscess, and no further trouble occurred whilst the patient was in my hands. I saw the same patient about a year afterwards, the tooth appeared to be in healthy condition.

Sometimes a portion of the pulp, more or less small, will remain for a long time in the canal secreting pus, which is discharged into the pulp cavity. The presence of such a portion of pulp will generally be detected by the pain occasioned by contact with an instrument passed into the fang, even if the discharge of pus is not sufficient to be apparent upon examination. This is first to be got rid of, and it is sometimes difficult to bring into contact with it the arsenic to destroy its vitality. I generally pass the arsenic up to the point on the end of a piece of thread ; if its destruction cannot be accomplished by this means it must be removed with an instrument, regardless of the pain it inflicted. In these cases, however, it is necessary to observe well the precautions recommended in the last number, to avoid passing the instrument both in making the examination and removing any remains of the pulp, entirely through the foramen.

A discharge of matter through the fang, from the cause here mentioned, offers no other obstacle to the operation, than that the parts are in a more or less morbid condition, which must render them liable to inflammation from the irritation attendant upon what is done. Every care must be taken to prevent this or to subdue it when it occurs.

There is still a very important point to be considered before closing, that is, the age at which this operation may be attempted with propriety. It is very obvious that no success, but, on the contrary, bad results must follow this operation if attempted upon teeth before the fangs are fully formed, and unfortunately such cases frequently occur. This question was considered by Dr. J. D. White in a paper published some years ago in a medical journal ; I should be glad to see it republished. I cannot at present recollect the paper alluded to particularly, whether it gave any precise data by which to judge of the length of time

after the teeth have attained to their full size in the mouth for the complete formation of the fangs. Upon this point, further observation is needed in order to insure the preservation of many teeth of young persons without risk of injurious consequences. Such observations I have not yet been able to make to my satisfaction.

I now feel myself obliged to close these papers, with several subjects scarcely touched, which I had contemplated carefully considering when I engaged in writing them, as indeed is indicated by the title I have given to them. Pressing engagements occupy the whole of my time, and oblige me for the present to set aside this subject. At a future time, not far distant, I hope, if what I have presented should be thought to possess any value, it is my intention carefully to go over the whole ground, and treat, to the best of my ability in all its details, this particular subject, and all which bear any relation to it. I regret that absolute want of time has obliged me to allow a greater part of these papers to go before the profession in a cruder form than I am satisfied to see.

V. O. S.



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